State of Maine 1997 Backyard Trash Burning (BYB) Study

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EXECUTIVE SUMMARY

Air quality and the health effects of pollutants have become a growing concern in the state of Maine. At the same time the number of backyard trash incinerators has also increased. Smoke from these barrels contains many pollutants that travel at ground level, exposing those downwind to potentially health-threatening compounds.

In response to public concern about these health effects, the Maine State Legislature enacted LD 967, a clarification of open burning statutes, effective August 30, 1997. The law clarified open trash burning permitting procedures and requirements, restricted what materials can and cannot be burned, and limited burning to areas with no municipal waste collection service. LD 967 also mandated that the Department of Environmental Protection (DEP) examine the magnitude and impact of backyard burning in Maine, its causes and options for reducing its impact. The DEP developed this report to address those issues.

1. The Extent of Backyard Trash Burning (BYB) in Maine

The Department of Conservation Forestry Bureau surveyed town fire wardens and state forest fire rangers about backyard burning in each town and in groups of townships in the state.

The survey identified an estimated 8,510 backyard trash incinerators in the state of Maine, or about 1 barrel for every 144 people. The burn barrel per person ratio is significantly higher in some counties than in others, ranging from a low of 1 barrel per 1000 residents in Cumberland County to a high of 24 barrels per 1000 residents in Aroostook County. The data suggests that counties and municipalities with lower populations have a greater number of burn barrels in use.

The BYB survey also asked local fire wardens "*why they think*" people in their town burn their garbage in backyard incinerators. The qualitative responses encompass economics, culture, habits and inconvenience. The results showed that no single reason outweighed the others, but rather that most communities cited a combination of factors influencing people's tendency to burn garbage.

2. The Impact of BYB Emissions

There are two general ways of assessing potential emission impacts from backyard trash burning. One way is to estimate the total annual emissions to the environment. A second way of assessing potential emission impacts is to estimate concentrations of pollutants downwind from a burn barrel for comparison with various health-based ambient air guidelines or standards. A common method for estimating downwind concentrations is by air dispersion modeling. The present analysis applied both approaches. Central to both approaches are estimates of the amount of pollutants emitted from burn barrels into the air per unit weight of trash burned, referred to as emission factors. The report includes a discussion of emission factors for various pollutants emitted by burn barrels and uses emission factors in a modeling approach to estimate localized impacts and assess the public health risk such emissions might create.

Estimates of the potential total annual emissions were generated using recently developed EPA emission factors and the Maine BYB Survey results. The *estimated total mass of waste burned in Maine BYB Barrels* is **19,147 kg per day or 21 tons per day.**

On the basis of the total emissions results, fine particulates and dioxins appear to be at potential levels of localized public health concern. As such, these pollutants have been focused on in this report and are suggested for use as indicators of potential public health impact concerns when making risk management decisions. The estimated total annual emissions of other Hazardous Air Pollutants (HAPS) may be high enough to contribute to acute health effects but were not analyzed further due to limited resources.

On the basis of the TEQ total annual emissions estimates for dioxin/furan (7 to 23 grams per year), backyard incinerators appear to be a significant source of dioxin emissions in the state, when compared to other known sources of the pollutant such as municipal waste combustors. The analysis does estimate the total mass of dioxin/furan produced by burn barrels to be between 12,000 and 38,000 times higher than the dioxin/furan emitted by a clean-burning municipal waste combustor burning an equal amount of garbage**.**

The ash data also indicates cause for concern about dioxin/furan impacts (see Table 4). The ash content analysis yielded an estimated mass of ash generated by backyard burners of between 2,942,300 kg (3243 tons) and 3,732,039 kg (4113 tons) of ash produced annually with a dioxin content between 635 ppt and 2600 ppt (TEQ or toxic equivalency quotient); a concentration between 2.5 and 10.5 times higher than the state standard for maximum dioxin content in sludge that can be spread on land.

To determine whether localized pollutant emissions might be a concern for public health exposure, this study has used a modeling analysis approach to estimate the pollution impacts near a burn barrel. The EPA emission factors were used to characterize the types and concentrations of pollutants emitted. The estimated impacts were then compared to benchmarks or standards for acute and long term exposure.

Benchmarks for Comparison

Fine particulate matter (particles with diameters less than 10 micrometers) can penetrate to the deepest regions of the lung, and can accumulate in the respiratory system. Scientific studies have linked particulate matter, especially the fine particulate matter, with a series of significant health problems including premature death, respiratory related hospital admissions and emergency room visits, aggravated asthma, acute respiratory symptoms, including severe chest pain, gasping and aggravated coughing, chronic bronchitis, decreased lung function that can be experienced as shortness of breath, and work and school absences. [Reference: EPA fact sheet on Revised Particulate Matter Standards @ http:\\ttnwww.rtpnc.epa.gov/naaqsfin/pmfact.htm published July 17, 1997].

Toxicological studies for dioxin/furans have shown PCDDs and PCDFs can cause a number of deleterious effects in animals, including cancer, reproductive and development toxicity, immune system toxicity, a wasting phenomenon characterized by body weight loss, and organ toxicity. Some of these effects are manifested by long-term chronic exposures (e.g., cancer), while others can result from a single dose (e.g., immune system effects). Animal studies indicate that the most sensitive toxic effects (those occurring at the lowest exposures) are immune, reproductive and developmental effects. Importantly, these sensitive effects may result from short-term exposures.

The benchmarks of primary concern used for analysis in this study are

Federal and State Standards:

PM2.5: 65 mg/m3 24 hour National Ambient Air Quality Standard (NAAQS)

PM10: 150 mg/m3 24 hour Maine Ambient Air Quality Standard (MAAQS)

Maine Interim Ambient Air Guideline (MIAAG HAPS): *for long term exposure:*

Dioxin/Furans: 3.5×10^{-6} ug/m3 (IAAG - Subchronic Exposure guideline)

USDHHS Agency for Toxic Substances and Disease Registry Guideline (ATSDR):

for acute exposure:

Dioxin/Furan: 8.3×10^{-4} ug/m3 (ASTCR - Acute exposure guideline A)

1.8×10^{-4} ug/m3 (MeBOH - Acute exposure guideline B)

Modeling Simulation Results

PARTICULATES—ISCST3 screening and refined modeling of various types of open burning scenarios for typical recycler and non-recycler household waste in 55-gallon barrels shows that there are potential health risks from $PM_{2.5}$ and PM_{10} emissions. Just 15 minutes of open burning results in exceedances of the 24-hour PM_{10} MAAQS and 24-hour $PM_{2.5}$ NAAQS. The highest modeled impacts were located at flagpole receptors *within a few feet* of the source of open burning especially in windy conditions at levels around 2.7 times the 24-hour PM_{10} MAAQS and 5.8 times the 24-hour $PM_{2.5}$ NAAQS.

Results show the potential for health risks *within 26 feet* of the source of open burning from just 15-minutes of $PM_{2.5}$ and PM_{10} emissions, however, if open burning occurs for many hours in a day, then the potential health risk zone would expand further from the burn barrel.

DIOXIN/FURANS—The maximum 24-hour impact contribution from just 15-minutes of open burning was 7,700 times the 24-hour dioxin/furan IAAG. However, this impact occurred at just *1 meter* downwind from the barrel, and dropped rapidly with increasing angle off the centerline. Of more interest is the observation that 15-minutes of open burning results in PCDD/PCDF impacts two (2) times the subchronic exposure guideline, at a downwind distance of *500 meters* (1640 feet); and at *100 meters* the IAAG was exceeded even at 20 degrees from the plume centerline). It should be noted, however, that the zone of potential health risks was reduced to *148 feet* of the burn barrel or less when using the lower dioxin emission factors reported for the other three test cases. Although this study focused on the potential for maximum impacts, use of an 'average' PCDD/PCDF emission factor may be appropriate when making comparisons to the subchronic exposure guideline for making risk management decisions.

Risk Assessment/Risk Management Considerations:
Are these pollutant emissions at levels of concern for public health exposure?

The modeling results need to be viewed with some caution because the way burn barrels are used by any one individual is highly variable. The modeling analysis is also faced with uncertainties as a result of the variables inherent in the emission factors used, as well as the highly variable meteorological and topographical conditions at any one site. These uncertainties can create both higher and lower predicted impacts. Because there is no good data on the frequency, volume and duration of burning from individual burn barrels, current analyses have focused on potential acute exposures and health impacts, rather than long term exposures and impacts (e.g., cancer).

There are also risk assessment uncertainties, the *acute exposure* to dioxin/furans can act as an immunosuppressant making people more prone to become sick and less able to recuperate. It is not known what the effects of a weekly or bi-weekly exposure to such compounds could result in. Therefore, it is important to keep in mind that because of uncertainties in the toxicological studies, there may still be some level of concern for reproductive, developmental or other health impacts in the population from *subchronic exposure* impacts.

Given the modeling analysis predictions presented in this study, there appear to be scenarios under which barrel burning of trash could cause localized public health impacts. When making risk management decisions about backyard trash burning, state and local officials need to consider whether the risk is acceptable in their communities and/or whether it may be possible to burn without health impacts as long as reasonable distances are maintained from property lines and homes. The decision hinges on what level of risk people are willing to accept.

Since the dioxin/furan results appear to be at levels of most concern in the modeling analysis, it is recommended to use those impacts if/when considering a setback requirement approach. There is a strong argument for at least a 22 meter setback, based on potential acute exposure to dioxin and associated health effects. There is also some basis for a setback of 148 feet, based on modeling results using *average* emission factors for dioxin and a subchronic exposure guideline (potential for repeated exposure). Also, depending on the level of risk a community is concerned about, there is an argument for a setback of up to 500 meters, based on the subchronic exposure guideline for dioxin; which was exceeded out to 500 meters when using the *highest* dioxin emission impacts modeled in this analysis.

Keep in mind the high levels of dioxin/furan that have been found in the ash and the total mass annual emissions to the air. A survey of people practicing barrel burning in Illinois indicated that a significant number of respondents disposed of ash by spreading on gardens, piling for wind dissipation, or dumping in ditches or in the forest. Disposal in these ways may result in dioxins pervading food chains, resulting in additional routes of exposure beyond direct inhalation that can be a significant public health concern.

Total mass annual emissions to the air also look high in comparison to other known sources of the pollutant in Maine, and may warrant careful review by the Legislature as it considers ways to reduce the release of dioxins into the environment. The results from the present analysis will be used in the preparation of an inventory of dioxin sources in Maine and state and local risk management decisions may need to be revisited at that time.

Finally, in the case of backyard trash burning, the concern for public health exposure is the same for both the person who burns the trash and the neighbors who are impacted. Public health concern does not start or stop at someone's property line. State and local officials should identify what level of risk the community is willing to accept from back yard burn barrels and at a minimum establish recommended guidelines for impact on the 'burner' as well as those downwind of the barrel. If burning is allowed, officials need to remain cognizant of the impact on people with asthma and other respiratory or heart disease conditions and implement "public nuisance" statutes or other more protective measures when necessary. DEP strongly urges public officials to evaluate whether the risk to their community would be better managed by using an alternative waste management strategy.

3. Maine's Solid Waste Management & Recycling Infrastructure

In order to evaluate and recommend alternative waste management strategies to reduce backyard trash incineration, the Maine State Planning Office analyzed the existing solid waste management and recycling infrastructure in the state and the possible dis-incentives to recycle or dispose of waste properly. Maine waste management law establishes municipalities as the primary decision-makers with respect to solid waste management matters. Municipalities choose which other municipalities to cooperate with, how much commercially generated MSW they will handle directly, and what combination of management options to use. Analysis of the warden survey and SPO data showed a strong correlation between the existence of Municipal Trash Collection Services and low burn-barrel usage.

Participation in recycling increased from 72% in 1992 to an estimated 90% in 1996. Of the 404 municipalities represented in the 1996 reporting to the State Planning Office, 48% recycled at 35% or more. Analysis of the recycling and burn barrel data, however, found no correlation between recycling rates and numbers of burn barrels.

State law and local ordinances now prohibit backyard trash burning in at least 150 communities statewide, 128 of which are subject to the state level prohibition and 20 of which are corporate members of Regional Waste Systems, Inc. and by contractual requirement have adopted backyard burning bans. A survey of town fire wardens showed that the majority would like to see backyard burning banned or restricted to extreme circumstances.

For communities where economic reasons are the motivating factors for burn barrel use, finding ways to help communities cope with these costs may be helpful. For example, the island communities often have the highest expenses for many solid wastes and recyclables to the mainland and the BYB survey results show islands with the highest burn barrel use in the state. For communities where inconvenience is the motivating factor, making waste disposal and recycling options easier to use and extending them into rural areas could contribute to reduced burning. In areas where culture and habits are the main factor in burning, extensive education campaigns about the negative effects of burning could help people want to change their habits. One approach that could help reduce municipal waste management costs would be development of a statewide source reduction strategy such as requiring a reduced packaging requirement on products sold in Maine.

4. Backyard Burning Study Group Recommendations

The DEP Bureau of Air Quality reviewed the findings of the backyard burning study and developed recommendations for legislative action.

The Study Group considered five options for potential legislation:

1) Statewide prohibition of backyard burning
2) Statewide prohibition of backyard burning with rural exemptions
3) Statewide prohibition of backyard burning with rural exemptions for overwhelming financial burden
4) Allowed rural burning with setbacks
5) Allowed burning with setbacks in any community without municipal trash collection service

The Study Group Advisors made the following recommendations:

1) Setbacks: The Study Group recommended requiring a burn barrel setback in relationship to neighboring structures or property lines. The group also recommended an "advisory" burn barrel setback distance from the burners' own homes.

2) Municipal Incentives: The Study Group recommended implementing a program to enable communities to deal with backyard burning at the local level by providing incentives, such as recycling credits, or tax credits to encourage towns to provide municipal trash collection service and develop BYB ordinances.
3) Education: The Study Group recommended implementing an educational component geared toward younger generations and modeled after successful recycling and seatbelt education campaigns.

DEP Recommendations
The Study Group has identified an initial course of action that would have the effect of limiting public exposure to local emissions. The course of action would be implemented through the Group's proposed legislation.

DEP recommends discussion of this proposed legislation in the context of a "first step" toward an ultimate goal of eliminating the harmful health and environmental impacts of backyard burning. Additional considerations should include: (1) identifying the level of public health risk a community is willing to accept; whether setbacks or elimination would be most desirable as the risk management strategy (2) establishing a state-wide minimum setback requirement of at least 300 feet from neighboring property lines or structures; (3) advisory setbacks from burners' own residences; (4) local incentives to reduce backyard burning and implement environmentally friendly alternative waste management strategies.

ACKNOWLEDGMENTS

The Department of Environmental Protection extends thanks to all of the people who shared their input and support throughout the process of this report. Thanks go to DEP Bureau of Air Quality staff for collecting, entering and interpreting data, coordinating study group members and writing the report. Thanks especially to the Department of Conservation Bureau of Forestry, Forest Fire Control Division staff and all of the Forest Fire Rangers who circulated and returned over 98% of the surveys; to town fire wardens for taking the time to respond to the questions; to the other members of the Backyard Burning Study Group who attended meetings, provided data, text and feedback, including the Bureau of State Planning, the Department of Human Services BOH toxicologist, the Maine Lung Association, the Maine Municipal Association and the Maine State Legislators.

INTRODUCTION TO THE SCOPE AND GOALS OF THE STUDY

Air quality and the health effects of pollutants have become a growing concern in the State of Maine. At the same time the number of backyard trash incinerators has also increased. Smoke from these barrels contains many pollutants that travel at ground level, exposing those downwind to potentially health-threatening compounds.

In response to public concern about these health effects, the Maine State Legislature enacted LD 967, a clarification of open burning statutes, effective August 30, 1997. The law clarified open trash burning permitting procedures and requirements, restricted what materials can and can not be burned, and limited burning to areas with no municipal waste collection service. LD 967 also mandated that the Department of Environmental Protection (DEP) examine the magnitude and impact of backyard burning in Maine, its causes, and options for reducing its impact. The DEP developed this report to address those issues.

The DEP Bureau of Air Quality formed a study group with the Department of Conservation (DOC), Bureau of Forestry, Forest Fire Division, and the Maine State Planning Office (SPO). Other BYB Study Group members that served in an advisory capacity include the Maine Department of Human Services (DHS) toxicologist, Maine Municipal Association, American Lung Association of Maine and several interested Legislators (see Technical Support Documents, Appendix 4A for a complete listing of contributors and participants). The Study Group's mission was to gather and analyze data, report findings and generate recommendations for legislative consideration.

The report addresses the LD 967 Questions listed below:

SECTION 1: THE EXTENT OF BACKYARD BURNING IN MAINE

The extent of backyard burning in the state and a comparison of the extent of, and issues involved with, backyard burning in urban, suburban and rural areas.

The impact of cultural influences and economic incentives on backyard burning.

SECTION 2: IMPACT OF BACKYARD BURNING EMISSIONS ON AIR QUALITY

The impact of BYB on local air quality and the level of human exposure to pollutants.

SECTION 3: RECYCLING /SOLID WASTE MANAGEMENT INFRASTRUCTURE

The state SWM and recycling infrastructure and its impact on backyard burning.

Alternative solid waste management strategies that may reduce backyard burning.

SECTION 4: OPTIONS TO CONSIDER TO REDUCE BYB AND THEIR IMPACTS

Recommendations for where backyard burning should be prohibited or restricted.

The impact of prohibiting backyard burning on municipalities, including island communities, and on the costs of solid waste management.

METHODS OF DATA COLLECTION

During the summer of 1997, the DOC Bureau of Forestry, Forest Fire Control Division surveyed town fire wardens and state forest fire rangers about backyard burning in each town and in groups of townships in the state. The survey questions encompassed the number of barrels in each town, the availability of alternative waste disposal services, the frequency of burning, the reasons for burning, the desirability of setback requirements and wardens' comments.

Due to the efforts of Maine Forest Fire Rangers, the backyard burning surveys yielded over a 98% return rate, with only 9 out of 545 surveys unaccounted for. Maine DEP Bureau of Air Quality analyzed the BYB survey data using spreadsheets, graphs and maps and developed this report.

Data on the emission rates of pollutants from backyard incinerators was obtained from a study prepared by the US Environmental Protection Agency (EPA) and New York State Department of Health (NYSDOH). Maine DEP used the EPA/NYSDOH burn barrel emission factors to model the localized impact of burn barrels. A Department of Human Services toxicologist advised the DEP on the best approach for analyzing this information and making comparisons to potential public health effects.

The Maine State Planning Office provided an analysis report and data on population, recycling rates, and solid waste expenditures by town. The SPO analysis supplies information on existing municipal solid waste management and recycling infrastructure throughout the state, as well as limited information on certain municipalities that prohibit backyard burning. Data from the Maine Municipal Association supplemented this analysis with information on municipal costs of solid waste management.

The BYB Study Group, including staff from DEP, DOC, SPO, DHS, MMA, American Lung Association and interested legislators, reviewed the findings of the survey and made the recommendations found in Section 4 of this report.

SECTION 1: THE EXTENT OF BYB IN MAINE

A. The extent of backyard burning in the state and a comparison of the extent of, and issues involved with, backyard burning in urban, suburban and rural areas.

During the summer of 1997, the DOC Bureau of Forestry, Forest Fire Control Division surveyed town fire wardens and state forest fire rangers about backyard burning in each town and in groups of townships in the state. The survey posed the following questions:

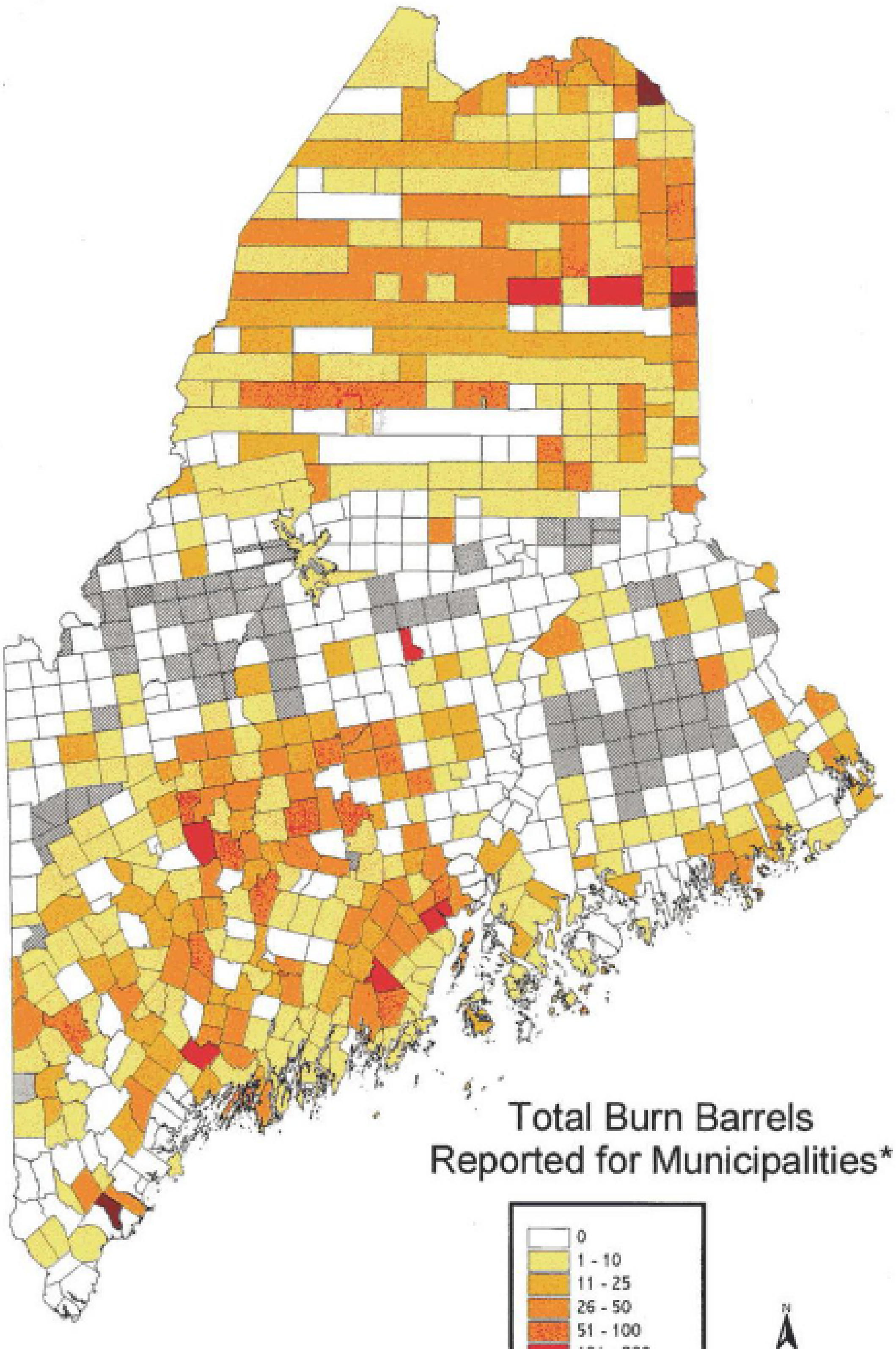
- Does the town have a “municipal trash collection service?”
- Does the town have a transfer station?
- Does the town provide any other waste disposal options?
- Please estimate the number of incinerators in your town or unit patrol:
  open type; enclosed type; other
- Please estimate how frequently these incinerators are used,
- Why do you think people are burning in incinerators in your area?
  Economic reasons? Cultural reasons: habits; inconvenience of getting to a transfer station; inconvenience of separating trash; other? Other?
- Do you feel that “setback” requirements would be desirable?
- Other Comments?

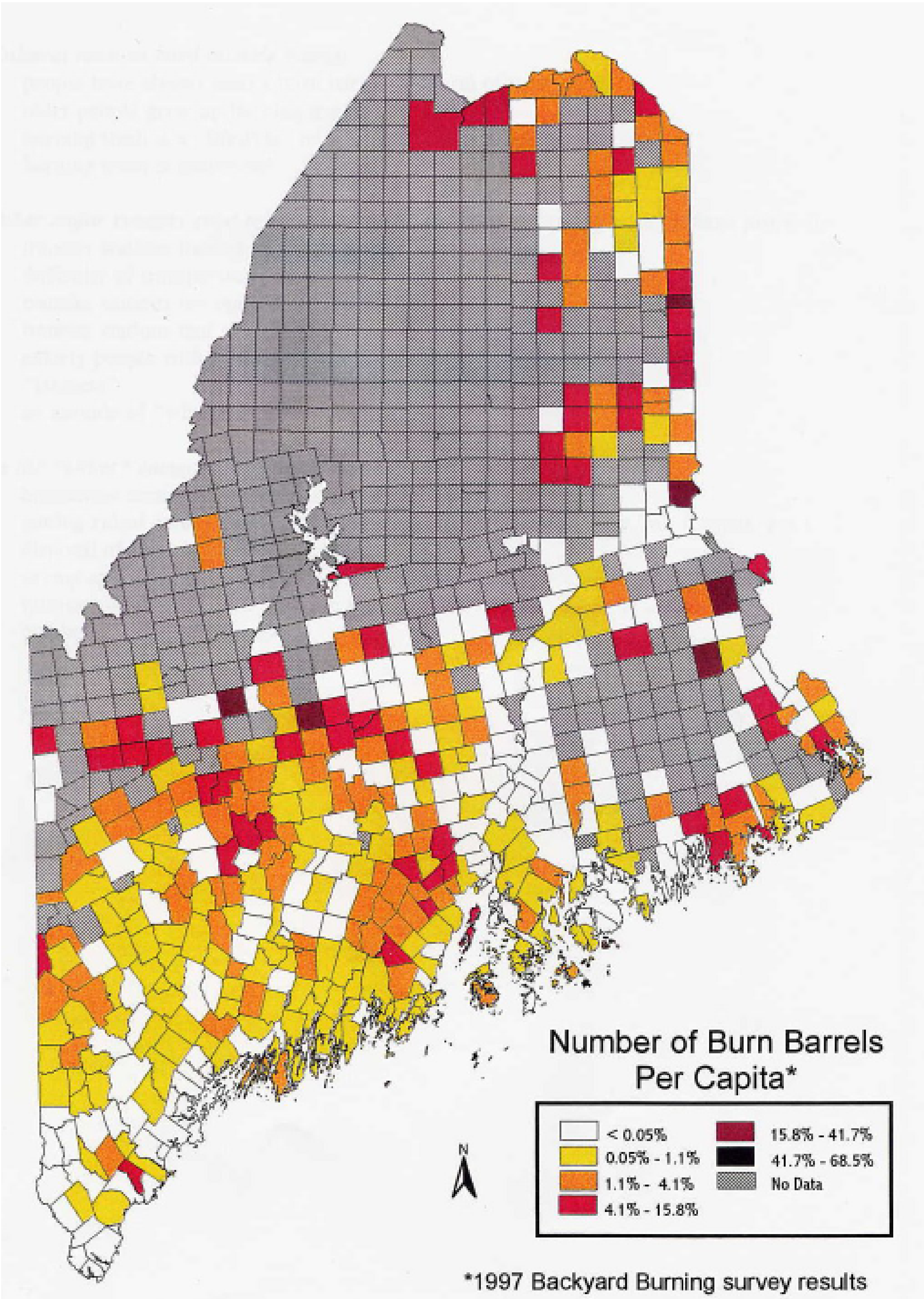
The survey identified an estimated 8,510 backyard incinerators in Maine, or about 1 barrel for every 144 people. Of these incinerators, 7,889 are open (an upright 55-gallon drum) and 621 are enclosed (a 55 gallon drum on its side, fitted with a door and a stovepipe). Table 1 summarizes the number of open and closed barrels by county, as well as the relative barrel to resident ratio. (Please note that, while wardens are in charge of permitting open burning, many unpermitted barrels exist without the wardens’ knowledge and are thus not included in this estimate.)

Table 1. Summary of Backyard Incinerators by County

1	2			3	4
	Warden Estimate Burn Barrels			**Population**	**Barrels Per 1000**
County*	**open**	**closed**	**total**	**7/10/94**	**Residents**
Androscoggin	405	29	434	103,882	4
Aroostook	1820	105	1925	79,334	24
Cumberland	317	7	324	248,009	1
Franklin	603	38	641	28,695	22
Hancock	238	31	269	48,611	6
Kennebec	368	27	395	117,227	3
Knox	323	52	375	37,074	10
Lincoln	140	7	147	31,022	5
Oxford	351	8	359	52,434	7
Penobscot	648	37	685	145,114	5
Piscataquis	287	50	337	17,594	19
Sagadahoc	140	1	141	33,383	4
Somerset	916	43	959	56,796	17
Waldo	532	94	626	28,743	22
Washington	491	85	576	33,571	17
York	310	7	317	166,812	2
State Total	**7889**	**621**	**8510**	**1,228,301**	**7**

**See TSD Appendix 1A for individual town listings.*


Total Burn Barrels
Reported for Municipalities*
0
1 - 10
11 - 25
26 - 50
51 - 100
101 - 200
201 - 300
No Data
N
*1997 Backyard Burning survey results


Number of Burn Barrels
Per Capita*
< 0.05%
0.05% - 1.1%
1.1% - 4.1%
4.1% - 15.8%
15.8% - 41.7%
41.7% - 68.5%
No Data
N
*1997 Backyard Burning survey results

IS THERE A RELATIONSHIP BETWEEN BURN BARREL USE AND POPULATION DENSITY?
OR RURAL VS. URBAN LIFESTYLES?
Based on the survey data, Column 4 in the table above indicates that the burn barrel per person ratio is significantly higher in some counties than in others, ranging from a low of 1 barrel per 1000 residents in Cumberland County to a high of 24 barrels per 1000 residents in Aroostook County. In an attempt to geographically depict the distribution of barrels, DEP mapped the burn barrel data using Geographic Information Systems (see Maps 1 & 2).

Map 1 shows the number of burn barrels and where they are located throughout the state. The unorganized territories were reported as large units or blocks of townships. On Map 1 these blocks of townships show up as lines across the northern counties.

Map 2 represents barrel use in relation to population density in each community. In map 2 the unorganized territories are not included because population data was not available.

The survey data was sorted to identify correlations between barrel use and population densities. The **graph in Figure 1.1** compares county population to burn barrel use and shows an inverse relationship; as county population decreases, burn barrel use increases. This indicates higher burn barrel use in rural areas of the state. The **graph in Figure 1.2** compares population to barrels in use at the town level. Again the data demonstrates municipalities with lower populations have a greater number of burn barrels in use. ***As towns get progressively smaller in Maine, the ratio of burn barrels to population increases.***

B. What is the impact of cultural influences and economic incentives on backyard incineration?
The BYB survey also asked local fire wardens "*why they think*" people in their town burn their garbage in backyard incinerators. The qualitative responses graphed in **Figure 1.3** encompass economics, culture, habits and inconvenience.

The data was sorted by the number of barrels per reason given for each of the towns. Many town wardens checked two or more reasons. The burn barrels in these towns were listed once for each reason given. Figure 1.3 indicates that ***no single group of reasons disproportionately influences the number of barrels located in the state.***

Survey General Comments: Reasons
Listed below is a summary of the local fire wardens' responses to this inquiry. The complete listing of survey responses can be found in TSD Appendix 1E.

Economic issues involved in backyard incineration include:
- charges by the transfer station per pound or per bag of garbage (generally between $.50 and $2 per bag)
- the cost of driving long distances to a transfer station
- fees charged by waste collection services.

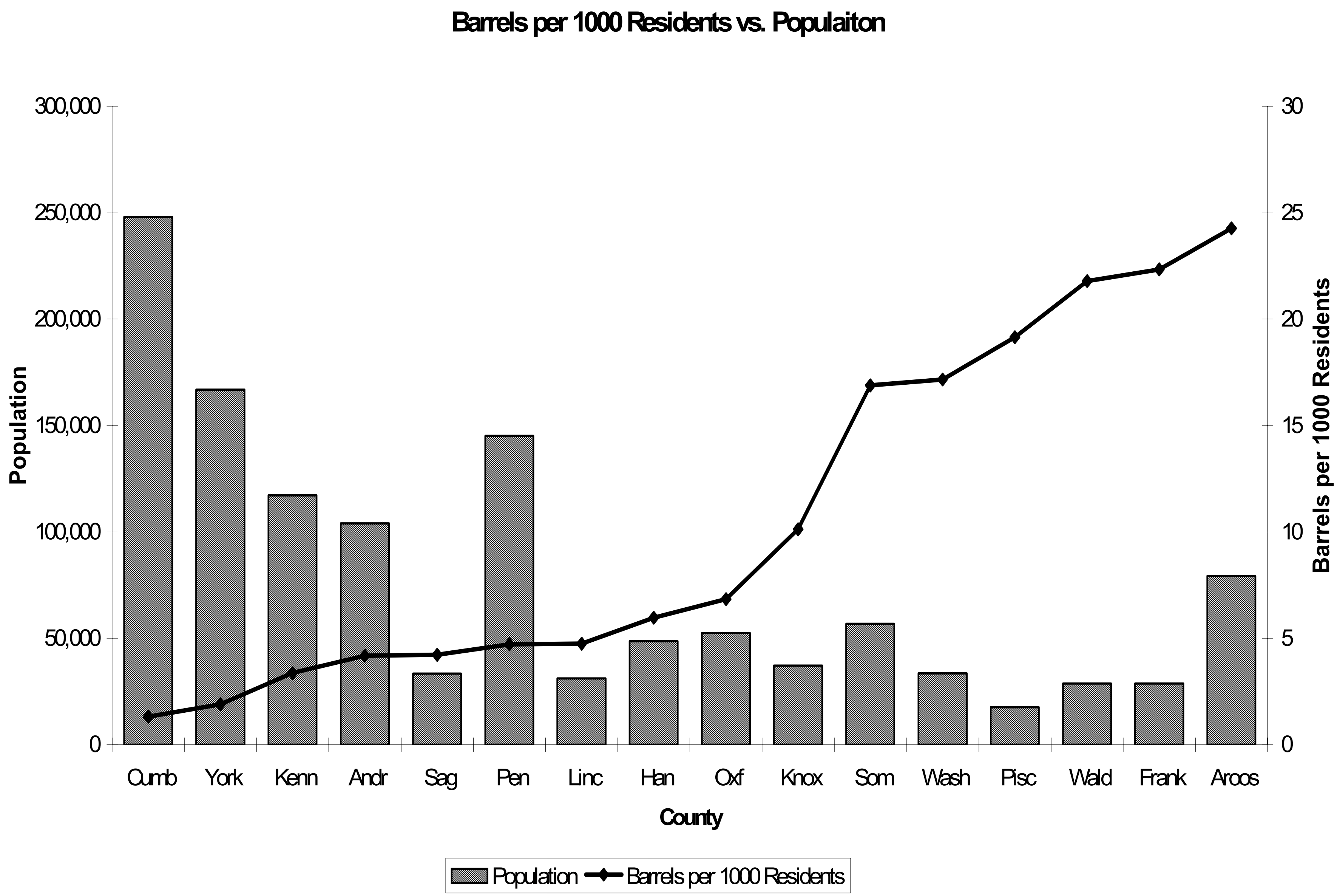
Cultural reasons cited include habits:
- people have always used a burn barrel to get rid of their trash
- older people grew up burning trash
- burning trash is a "lifestyle" or a "way of life in Maine"

- burning trash is traditional

Other major reasons cited relate to the inconvenience of dealing with garbage properly:
- transfer stations located too far from residences
- difficulty of transporting garbage off of an island
- transfer stations not open at convenient times
- transfer stations that will not take all items
- elderly people with no transportation
- "laziness"
- an attitude of "why bother?"

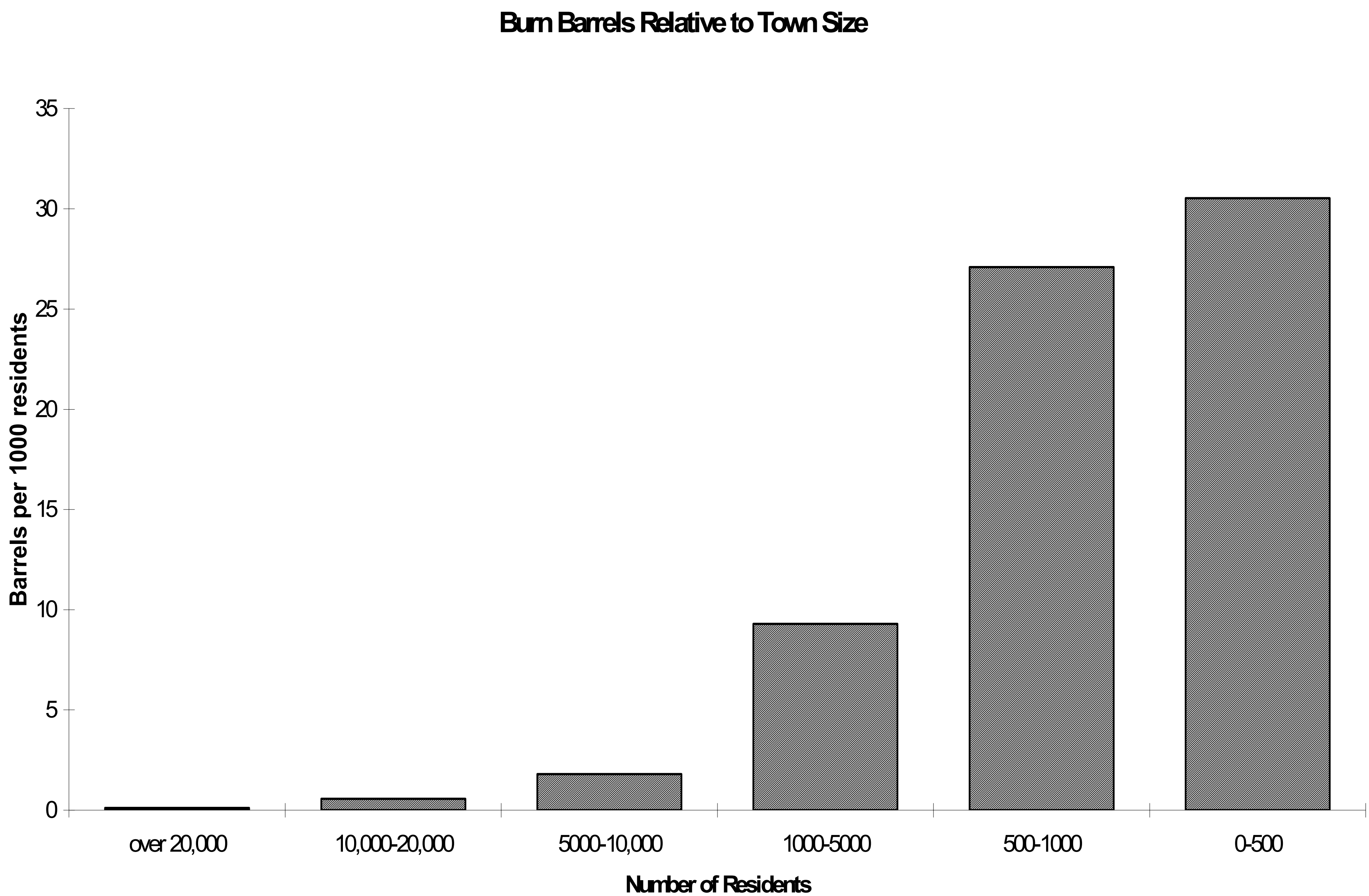
In the "Other" category, responses varied, including:
- businesses (construction, crematorium, Air Force base)
- getting rid of material transfer stations won't take (leaves, brush, oil, fishnets, etc.)
- disposal of private papers and personal mail
- saving space in the landfill
- fascination with fire or a "need to burn"
- dislike of neighbors downwind

Figure 1.1



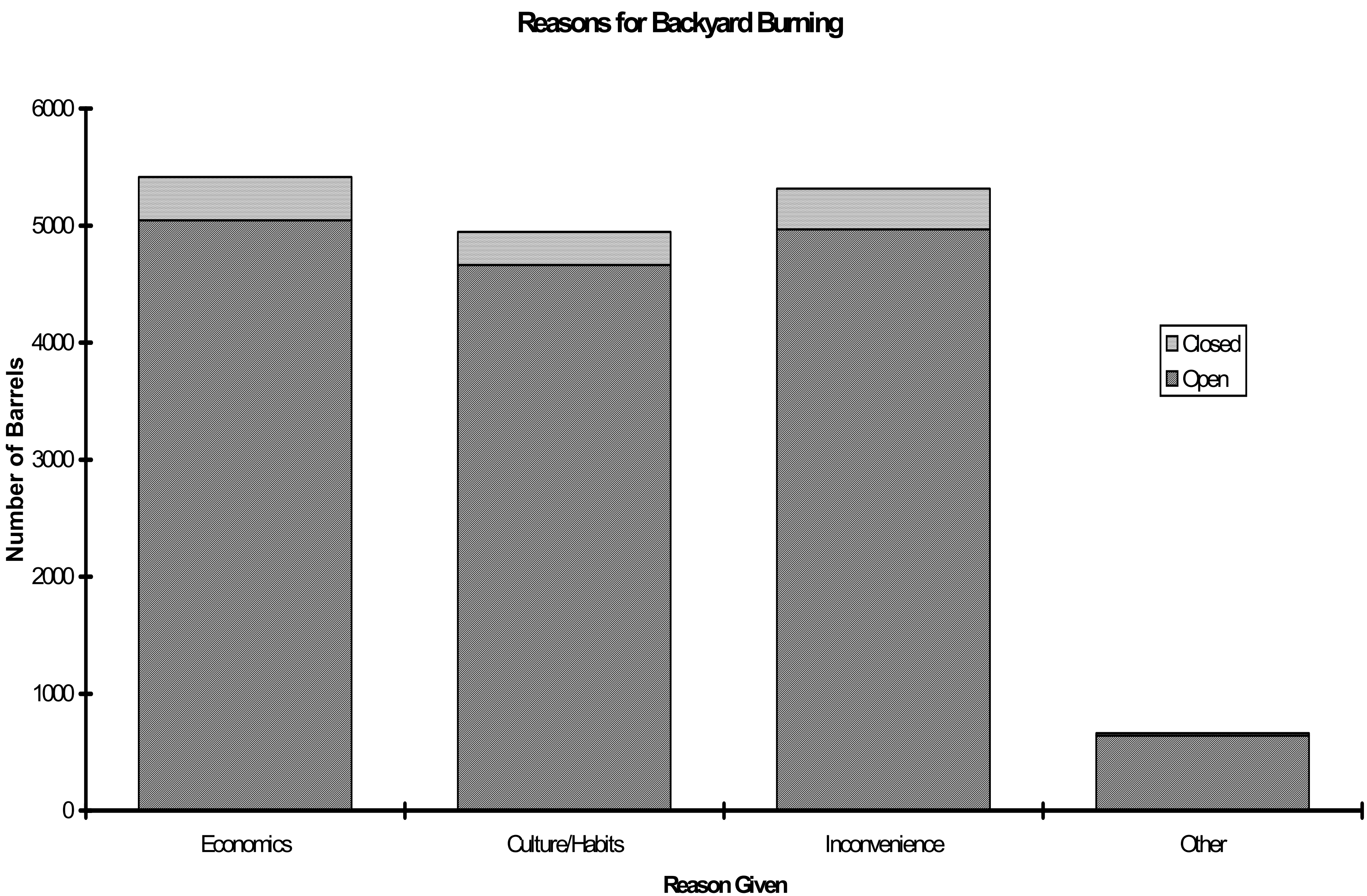
Barrels per 1000 Residents vs. Populaiton
Population
300,000
250,000
200,000
150,000
100,000
50,000
0
Cumb
York
Kenn
Andr
Sag
Pen
Linc
Han
Oxf
Knox
Som
Wash
Pisc
Wald
Frank
Aroos
County
Barrels per 1000 Residents
30
25
20
15
10
5
0
Population
Barrels per 1000 Residents

Figure 1.2



Burn Barrels Relative to Town Size
Barrels per 1000 residents
35
30
25
20
15
10
5
0
over 20,000
10,000-20,000
5000-10,000
1000-5000
500-1000
0-500
Number of Residents

Figure 1.3


Reasons for Backyard Burning
Number of Barrels
6000
5000
4000
3000
2000
1000
0
Closed
Open
Economics
Culture/Habits
Inconvenience
Other
Reason Given

SECTION 2: THE IMPACT OF BYB EMISSIONS ON AIR QUALITY

There are two general ways of assessing potential emission impacts from backyard trash burning. One way is to estimate the total annual emissions to the environment. This is the approach commonly used in Toxic Release Inventories and is especially relevant measure for persistent and/or bioaccumulative pollutants like mercury, lead, polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDFs). (PCDDs and PCDFs, are commonly referred to as just dioxins and dioxin/furans.)

A second way of assessing potential emission impacts is to estimate concentrations of pollutants at various distances downwind from a burn barrel for comparison with various health-based ambient air guidelines or standards. A common method for estimating downwind concentrations is by air dispersion modeling.

Both approaches were used in the present analysis and are described below. Central to both approaches are estimates of the amount of pollutants emitted from burn barrels into the air per unit weight of trash burned. These estimates are referred to as emission factors. Section 2.A. begins with a discussion of emission factors for various pollutants emitted by burn barrels. Section 2.B. presents the total mass emissions of pollutants to the environment. Section 2.C. presents estimates of modeled downwind concentrations of pollutants emitted from burn barrels and comparisons with ambient air health-based guidelines and standards. Section 2.D. presents a discussion of the findings from a risk management perspective and makes recommendations for risk management.

A. Emission Factors

DEP estimated and evaluated the pollutants emitted by backyard incinerators in order to characterize the types of pollutants and to determine the maximum and average impacts of burn barrels on local air quality and the potential effects of exposure to these pollutants on human health. DEP used emission factors to estimate Maine's annual BYB emissions and a common screening model to examine these pollutants in comparison to federal and state air quality standards and guidelines.

There have been three studies of emissions from burn barrels in the nation. For the present work, the DEP relied upon estimated emission factors recently reported in a 1996/97 Environmental Protection Agency (EPA)/New York State Department of Health (NYSDOH) study. (USEPA - Control Technology Center, Evaluation of Emissions From The Open Burning of Household Waste In Barrels, EPA-600/r-97-134 a & b, November 1997) The EPA study provided a characterization of a larger variety of pollutants of concern, including hazardous air pollutants.

The EPA study analyzed the emissions from the open burning of household waste in a test barrel. EPA researchers estimated the amount and composition of waste generated by two families of four; one that recycles part of their waste and burns the rest (recycler), and one that burns all of their waste (non-recycler). Researchers then ran five test burns, two with the avid recycler's garbage, one a blank (no waste) to monitor ambient air in the burn hut, and two with the non-recycler's garbage. The tests were conducted in a burn hut designed to imitate conditions of a backyard burn and to monitor the mass of waste burned, the temperature of the burns, pollutant emissions and concentrations in the remaining composite ash.

The emission factors provide limited data reflecting only duplicate test burns with trash from an avid recycler and a nonrecycler, for a total of four test runs. There is some degree of variability in emission estimates with emission factors for dioxin (PCDD/PCDF) varying by more than a factor of 10, notably one of the four runs had a particularly high estimate (0.005 mg 2,3,7,8-TCDD toxic equivalents per kilogram trash burned, mg TCDD-TEQ/kg) while the other three runs were fairly similar.

Although the composition of the waste burned in the EPA/NYSDOH tests contains total household waste (plastics, metal, food, etc.) while Maine now legally allows only paper and wood to be incinerated in burn barrels, the data is currently the best available in the United States. In addition, based on BYB survey responses, there is considerable likelihood that the New York State waste is probably a fair representation of materials being burned by many Maine residents due to low compliance rates with the new Maine restrictions on allowable materials burned.

B. Maine Total BYB Annual Emission Estimates

Estimates of the potential annual emissions were generated using the EPA emission factors and the Maine BYB Survey results. **Tables 2 and 3** list the *Estimated Annual Emissions from Backyard Incinerators in Maine*. The tables were derived by calculating the Maine data (8,510 burn barrels, the average waste generated per person, average household size, and recycling rate) with estimated total mass of waste burned in Maine BYB Barrels (19,147 kg per day or 21 tons per day). The tables list the daily and annual emissions for selected pollutants based on this estimate of Maine trash burned in backyard barrels. The last column shows comparative emissions from a clean-burning Municipal Waste Combustion facility burning an equal mass of waste. *Table 2 reflects a worst-case scenario*, using the highest emission factor for each of the pollutants from the EPA study, while the data in *Table 3 represent an average* of the emission factors for the four tests. *Table 4 lists the estimated mass of ash* produced annually by BYB and the total content of dioxins and furans in the ash.

Based on the Total Emissions results, fine particulates and dioxins appear to be at potential levels of localized concern. As such, these pollutants have been focused on in this report and are suggested for use as indicators of potential public health impact concerns when making risk management decisions. There are additional pollutants reported that may be of potential concern as well that may deserve further analysis in the future.

Total Annual Emissions Results

Backyard incinerators appear to be a significant source of dioxin emissions in the state, when compared to other known sources of the pollutant such as municipal waste combustors based on the TEQ total annual emissions estimates in Tables 2 & 3 for dioxin/furan (7 to 23 grams/year). (TEQs - Weighting systems have been derived to put individual PCDDs and PCDFs on a common toxicological scale relative to 2,3,7,8-TCDD, referred to as *2,3,7,8-TCDD Toxic Equivalents*, or *TEQs*.) Although the state is developing an inventory of dioxin sources, it is not yet available for comparison. Tables 2 and 3 do however, show the total mass of dioxin/furan produced by burn barrels to be between 12,000 and 38,000 times higher than the dioxin/furan emitted by a clean-burning municipal waste combustor burning an equal amount of garbage.

The ash data also indicates cause for concern about dioxin/furan impacts (see Table 4). The ash content analysis yielded an estimated mass of ash generated by backyard burners of between 2,942,300 kg (3243 tons) and 3,732,039 kg (4113 tons) of ash produced annually with a dioxin content between 635 ppt and 2600 ppt (TEQ or toxic equivalency quotient); a concentration between 2.5 and 10.5 times higher than the state standard for maximum dioxin content in sludge that can be spread on land. Although Maine DEP does not have any information on how backyard burn barrel owners dispose of their ash, an Illinois Backyard Burning Study reported that 12% of respondents tilled ash into gardens, 9% buried ash in the ground, 8% piled ash for wind dispersion and 36% dumped ash into ditches, fields and forests. This presents concerns for bio-accumulation of dioxin/furans into surface water.

The estimated concentrations of HAPS in Tables 2 and 3 may also contribute to public health impacts. These pollutant levels warrant additional consideration at a future time but have not been included in the modeling simulation as a result of limited resources. That analysis, presented in Section 2C of this report focuses on fine particulates, dioxins/furans and some limited information on lead, benzene and toluene emissions.

Table 2. Estimated Total Annual Emissions from Backyard Incinerators in Maine
Maximum or ***Worst-Case Scenario***

1	2	3	4	5
Pollutants of Concern	Burn Barrel Emission Rate EPA Study (Mass Emitted Per kg Waste Combusted)	Estimated Maine* Daily Burn Barrel Emissions per household (grams)	Estimated Maine* Total Annual Burn Barrel Emissions (kilograms)	Comparative Municipal Waste Combustion Facility** Emissions (kilograms)
Criteria Pollutants				
Fine Particulates (PM2.5)	20.07 g/kg	41.0	95,521	228
Particulates (PM10)	21.28 g/kg	43.5	101,279	insignificant
Bio-accumulative Pollutants				
Total Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (PCDD/PCDF)	0.5 mg/kg	0.0008	2	0.00006
PCDD/PCDF as 2,3,7,8 TCDD Toxic Equivalency (TEQ)***	0.005 mg/kg	0.000007	0.023	N/A
Polychlorinated Biphenyls (PCBs)	3.1 mg/kg	0.006	15	insignificant
Gaseous Mercury (Hg)	0.0023 g/kg	0.0034	10.7	
Particulate Phase Mercury (Hg)	0.000081 g/kg	0.00012	0.39	
Other Hazardous Air Pollutants				
Volatile Organic Compounds (VOCs)	2916 mg/kg	12.6	29,256	1047
Semi-Volatile Organic Compounds (SVOCs)	0.7 g/kg	1.4	3,364	insignificant
Polycyclic Aromatic Hydrocarbons (PAHs)	82.4 mg/kg	0.2	392	insignificant
Chlorobenzenes	1.7 g/kg	3.5	8,224	insignificant
Aldehydes and Ketones	4.0 g/kg	8.1	18,838	insignificant
Hydrogen Chloride (HCl)	3.3 g/kg	6.7	15,616	125.6
Hydrogen Cyanide (HCN)	0.2 g/kg	1.5	3,463	insignificant

*Calculations based on:
Maine waste production = 1.2 kg./capita/day; Average household size = 2.5 people; Number of burn barrels in Maine = 8,510; Maine average recycling rate = 25% ;Combustion rate = 68.1% of original mass burned
**Based on data from EPA document AP 42, except VOC, which is based on stack testing. Pollutants with "insignificant" emissions are destroyed in the combustion process.
***TEQs - Weighting systems have been derived to put individual PCDDs and PCDFs on a common toxicological scale relative to 2,3,7,8-TCDD, referred to as *2,3,7,8-TCDD Toxic Equivalents*, or *TEQs*.

Table 3. Estimated Total Annual Emissions from Backyard Incinerators in Maine
Average Emission

1	2	3	4	5
Pollutants of Concern	Burn Barrel Emission Rate EPA Study (Mass Emitted Per kg Waste Combusted)	Estimated Maine* Daily Burn Barrel Emissions Per Household (grams)	Estimated Maine* Total Annual Burn Barrel Emissions (kilograms)	Comparative Municipal Waste Combustion Facility** Emissions (kilograms)
Criteria Pollutants				
Fine Particulates (PM2.5)	11.4 g/kg	34.2	45,908	194
Particulates (PM10)	12.3g/kg	37.0	49,721	insignificant
Bio-accumulative Pollutants				
Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (PCDD/PCDF)	0.2 mg/kg	0.0002	0.64	0.00005
PCDD/PCDF as 2,3,7,8 TCDD Toxic Equivalency (TEQ)***	0.002 mg/kg	0.000006	0.007	N/A
Polychlorinated Biphenyls (PCBs)	1.9 mg/kg	0.003	8	insignificant
Gaseous Mercury (Hg)	0.0013 g/kg	0.0017	5.18	
Particulate Phase Mercury (Hg)	0.00003 g/kg	0.000039	0.12	
Other Hazardous Air Pollutants				
Volatile Organic Compounds (VOCs)	3165 mg/kg	5.5	12,807	890
Semi-Volatile Organic Compounds (SVOCs)	0.4 g/kg	1.3	1,714	insignificant
Polycyclic Aromatic Hydrocarbons (PAHs)	45.0 mg/kg	0.08	182	insignificant
Chlorobenzenes	0.7 g/kg	2.2	2,896	insignificant
Aldehydes and Ketones	1.5 g/kg	4.41	5,942	insignificant
Hydrogen Chloride (HCl)	1.3 g/kg	4.0	5,419	107
Hydrogen Cyanide (HCN)	0.3 g/kg	1.0	1351	insignificant

*Calculations based on: Maine waste production = 1.2 kg./capita/day; Average household size = 2.5 people; Number of burn barrels in Maine = 8,510; Maine average recycling rate = 25%; Combustion rate = 57.9% of original mass burned

**Based on data from EPA document AP 42, except VOC, which is based on stack testing. Pollutants with "insignificant" emissions are destroyed in the combustion process.

***TEQs - Weighting systems have been derived to put individual PCDDs and PCDFs on a common toxicological scale relative to 2,3,7,8-TCDD, referred to as *2,3,7,8-TCDD Toxic Equivalents*, or *TEQs*.

Table 4. Dioxins and Furans in Composite Ash Sample

	PCDD/PCDF Concentration EPA Study ng/kg (ppt) ash		Total Ash Produced Annually By Maine Burn Barrels kilograms/year		Total PCDD/PCDF in Annual Ash grams/year	
	Total	TEQ	Total	TEQ	Total	TEQ
Worst-Case	48,891	2,586	3,732,039	3,732,039	182	10
Low	7,356	635	2,229,439	2,229,439	16	
Average	28,123	1,611	2,942,300	2,942,300	83	5

C. Risk Assessment: Modeling Simulation of burn barrel emissions, how they move through the air, modeling uncertainties/variables and whether the air may be unhealthy to breathe.

To determine whether localized pollutant emissions might be a concern for public health exposure, this study has used a modeling analysis approach to estimate the pollution impacts near a burn barrel. The EPA/ NYSDOH emission factors were used to characterize the types and concentrations of pollutants emitted. The estimated impacts were then compared to benchmarks or standards for acute and long term exposure. The pollutants appearing to be of most concern from backyard trash burning are fine particulates (PM2.5 and PM10), bioaccumulative pollutants and other hazardous air pollutants (HAPS) including lead and benzene.

1. Air Dispersion Modeling

In order to model the concentration of pollutants downwind from a burn barrel, a number of key features capable of influencing air concentrations had to be considered. A particular amount of trash (15 to 30 lbs) was assumed burned in a given burn event. Emissions from a burn barrel have been shown to vary during the course of a burn event, with most emissions occurring in the first 30 minutes of burning. Thus, time dependent emissions were assumed. Emissions exiting a barrel are hot relative to ambient air, and have a tendency to rise vertically as hot air is less dense than cooler air. This "buoyancy effect" also needed to be considered as it influences dispersion of emissions.

Winds transport emissions in a particular direction and in conjunction with degree of stability in the lower atmosphere determines how far emissions are dispersed downwind. Hence, it is necessary to either assume a particular set of wind and atmospheric stability conditions, or perform modeling using historical meteorological data—both approaches were used in the present analysis.

Topography can influence exposure to pollutants by controlling the relative height of a person (receptor) relative to the burn barrel. Emissions could be transported almost completely overhead of a receptor located directly downwind but downhill of a burn barrel. Flat terrain would result in higher exposures, and still higher exposures might result if the barrel was located downhill from the receptor. Flat terrain was assumed in the present modeling work.

Industrial Source Complex Short Term Dispersion Model[3] (ISCST3) was the model used for this study because it is considered by regulatory agencies and the regulated community as being one of the standard "workhorse" regulatory models for screening and sequential "refined" modeling analyses and it can handle the variable emission scenarios and 15-minute averaging period impacts that were required for this study. Figures 2.1 and 2.2 illustrates some of the major features of classical air dispersion modeling. For a given averaging time (e.g., 1-hour) with a corresponding set of average meteorological conditions (e.g., NE wind at 10 mph), emissions can be thought of as having been dispersed in the shape of a horizontal cone, referred to as a *plume*, with the highest concentrations at the point of the cone.

The plume centerline refers to the horizontal line running through the center of the cone and in the direction of the wind flow. For any given downwind distance concentrations are highest along the centerline, decreasing with increasing distance along the centerline from the barrel. For any given downwind distance, concentrations decrease with increasing distance on either side of the plume centerline (*lateral dispersion*) and both above and below the centerline (*vertical dispersion*). The *receptor* refers to a particular downwind location and a particular above ground height. For example, when modeling a child's exposure a receptor height of 3-feet is commonly assumed, 5-feet for an adult.

As noted above, two modeling analyses were performed: *screening modeling* generates predictions based on a single wind direction and varying wind speeds; *refined modeling* using 5-years of historical meteorological data with a variety of wind directions and wind speeds. In screening modeling, the model assumes steady-state conditions meaning that meteorological conditions are assumed constant for 15 minutes and that the child (a 3-ft receptor) or adult (a 5 ft receptor) stand in place for 15-minutes (steady state conditions) breathing in pollutants of the plume whose path is directly in line with the child or adult. In refined modeling, 15 minute steady state conditions are also used but many more meteorological conditions are considered in the analysis. In both cases, the EPA/NYSDOH study was relied upon to define time-dependent emission factors, exit gas temperatures and exit gas velocities used in the modeled scenarios.

The dispersion modeling predicted 15-minute and 1-hour average concentrations. Since health benchmarks are based on a 24-hour averaging time, downwind concentrations had to be converted to this basis. To compare 15-minute and 1-hour impacts to 24-hour standards it was necessary to average out these 15-minute and 1-hour impacts over a 24-hour period. This was done by assuming a single burn event in any given day and that no more than 30-lbs of trash were burned in any single burn event (e.g., when modeling a 1-hour average impact, emissions were assumed negligible for the remaining 23 hours).

Results summarized in the next section include receptor location and magnitude of specific pollutant impacts (listed in Table 5), and the effect of downwind distance and lateral distance from the plume centerline on predicted air concentrations (Figures 2.3, 2.4 and 2.5). Table 6 (screening modeling) and Table 7 (refined modeling, 15 minutes only) present results adjusted to a 24-hour averaging period for comparison with health-based ambient air standards and guidelines.

A more in-depth description of the air dispersion modeling work prepared by DEP Chief Meteorologist can be found in Appendix 2A of the Technical Support Document

2. Health-Based Ambient Air Standards and Guidelines; Benchmarks for Comparison/Evaluation
Of the pollutants addressed, only PM_{10}, $PM_{2.5}$ lead (Pb) and Chromium (Cr) have an enforceable Maine Ambient Air Quality Standard (MAAQS) or National Ambient Air Quality Standard (NAAQS). The Maine Bureau of Health has derived non-enforceable Interim Ambient Air Guidelines (IAAG) for a number of other compounds. Depending on the compound, these IAAGs can include values for short-term averaging periods (e.g., 15-minute or 24-hours) long-term averaging periods (e.g., 1-year or more), or both. Table 8 lists IAAGs for compounds considered in the present work. A detailed description of health effects ascribed to these chemicals is included in Appendix 2B of the Technical Support Document. In addition to the IAAGs listed in Table 8, the Bureau of Health derived a range of acute inhalation exposure benchmarks for dioxins for use by the DEP in the present work. The basis and rationale for deriving acute inhalation exposure benchmarks is described below.

Fine Particulate Emission Standards
Fine particulate matter (particles with diameters less than 10 micrometers) can penetrate to the deepest regions of the lung, and can accumulate in the respiratory system. Scientific studies have linked particulate matter, especially the fine particulate matter, with a series of significant health problems including premature death, respiratory related hospital admissions and emergency room visits, aggravated asthma, acute respiratory symptoms, including severe chest pain, gasping and aggravated coughing, chronic bronchitis,

decreased lung function that can be experienced as shortness of breath, and work and school absences. [Reference: EPA fact sheet on Revised Particulate Matter Standards @ http:\\ttnwww.rtpnc.epa.gov/naaqsfin/pmfact.htm published July 17, 1997].

These health and welfare effects have been documented in a number of recent public community epidemiological studies at concentrations that extend well below those allowed by the current standards for particulate matter less than 10 micrometers in diameter (PM10) for both short-term (from less than 1 day to up to 5 days) and long-term exposure. In response, the USEPA recently enacted a new 24-hour National Ambient Air Quality Standard (NAAQS) for PM2.5 (particulate matter 2.5 micrometers or smaller). The short term health- and welfare-based standard for PM10 is a 24-hour Maine Ambient Air Quality Standard of 150 mg/m3. The recently enacted NAAQS for PM2.5 is 65 mg/m3.

Hazardous Air Pollutant (HAPS) Emission Guidelines

Given the growing level of public concern about bio-accumulative and hazardous air pollutant contamination in Maine's air and water as a serious threat to the health of Maine people and wildlife, the level of hazardous air emissions from barrel burning needs to be carefully examined.

In addition to dioxin/furan and particulates, a number of Hazardous Air Pollutants (HAPS) are released by open burning of trash. The HAPS of most concern for public health are chromium, mercury, benzene, toluene, lead (Pb), hydrogen chloride (HCL), and polycyclic aromatic hydrocarbons (PAHs). Most HAPS have long term (chronic) health effects and are carcinogenic. A detailed description of health effects ascribed to some of these chemicals is included in TSD Appendix 2B.

HAPS —Acute Inhalation Exposure Benchmarks for Dioxins and furans (PCDD/PCDF)

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are a family of structurally similar compounds thought to act by a common toxicological mechanism, and are frequently referred to as simply dioxins. Some PCDDs and PCDFs are much more toxic than others. The most toxic member of this family, and by far the best studied, is 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (2,3,7,8-TCDD). Weighting systems have been derived to put individual PCDDs and PCDFs on a common toxicological scale relative to 2,3,7,8-TCDD, referred to as *2,3,7,8-TCDD Toxic Equivalents*, or *TEQs*.

Studies have shown PCDDs and PCDFs can cause a number of deleterious effects in animals, including cancer, reproductive and development toxicity, immune system toxicity, a wasting phenomenon characterized by body weight loss, and organ toxicity. Some of these effects are manifested by long-term chronic exposures (e.g., cancer), while others can result from a single dose (e.g., immune system effects). Animal studies indicate that the most sensitive toxic effects (those occurring at the lowest exposures) are immune, reproductive and developmental effects. Importantly, these sensitive effects may result from short-term exposures. [1]

The Maine Bureau of Health (BOH) derived a 24-hour interim ambient air guideline for PCDD/PCDFs as 2,3,7,8-TCDD toxic equivalents in 1993. The guideline is 0.0000035 micrograms per cubic meter (mg/m3), or 3.5 *picograms* per cubic meter (pg/m3).[2] This non-enforceable guideline is based on the reproductive toxicity of 2,3,7,8-TCDD. The 24-hour guideline is based on studies of rodents and monkeys dosed *daily* with 2,3,7,8-TCDD for either *years* or *months*, respectively. While the Bureau of Health believes this guideline is appropriate for screening analyses of ambient air monitoring data, BOH toxicologists view the 24-hour IAAG as being more appropriate for evaluating subchronic exposures (i.e., exposures occurring repeatedly for periods of days, weeks or months).

Given the interest in emissions of PCDDs/PCDFs from burn barrels and the apparently substantial annual emissions, the Bureau of Health recently derived an additional range of air concentrations considered appropriate for evaluating potential health effects following a single exposure event, referred to as acute inhalation exposure guidelines. The basis for these acute inhalation exposure benchmarks are a draft acute toxicity Minimal Risk Level (MRL) for 2,3,7,8-TCDD TEQs recently proposed by the U.S. Public Health Service, Agency for Toxic Substances and Disease Registry (ATSDR).[1] The proposed acute oral MRL for dioxin is based on the ability of 2,3,7,8-TCDD to weaken the immune system's ability to fight influenza following a single oral dose of dioxin. The range of air concentrations proposed by the Bureau of Health as benchmarks for an acute inhalation exposure event is 180 to 830 pg/m3.[3] (See Figure 2.6 for a comparison of modeled dioxin emissions to the various exposure guidelines.)

Benchmarks Summary

The benchmarks of primary concern used for analysis in this study are

Federal and State standards

PM2.5 65 ug/m3 24 hour National Ambient Air Quality Standard (NAAQS)

PM10 150 ug/m3 24 hour Maine Ambient Air Quality Standard (MAAQS)

Maine Interim Ambient Air Guideline (MIAAG HAPS)

for long term exposure:

Dioxin/Furans 3.5×10^{-6} ug/m3 (IAAG - Subchronic Exposure guideline)

USDHHS Agency for Toxic Substances and Disease Registry Guideline (ATSDR)

for acute exposure:

Dioxin/Furan 8.3×10^{-4} ug/m3 (ASTDR - Acute exposure guideline A)

1.8×10^{-4} ug/m3* (Me BOH -Acute exposure guideline B)

[1] See: Toxicological Profile for Chlorinated Dibenzo-p-Dioxins, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. September 1997 (Draft Update for Public Comment).

[2] A microgram is one millionth of a gram and a picogram is one millionth of a microgram.

[3] The acute inhalation exposure benchmark of 830 mg/m3 is obtained by applying a crude conversion of ATSDR's draft oral MRL to an inhaled dose basis. ATSDR derived their MRL using a 3-fold uncertainty factor for extrapolating toxicological responses observed in mice to humans. While ATSDR made a sound argument in support of using a 3-fold uncertainty factor, the Maine Bureau of Health has routinely used a factor of 10 when performing mouse-to-human species extrapolation. Using a factor of 10 for species extrapolation (along with assuming 100% of the inhaled dose is absorbed) would give a 24-hour acute inhalation exposure guideline of 180 mg/m3.

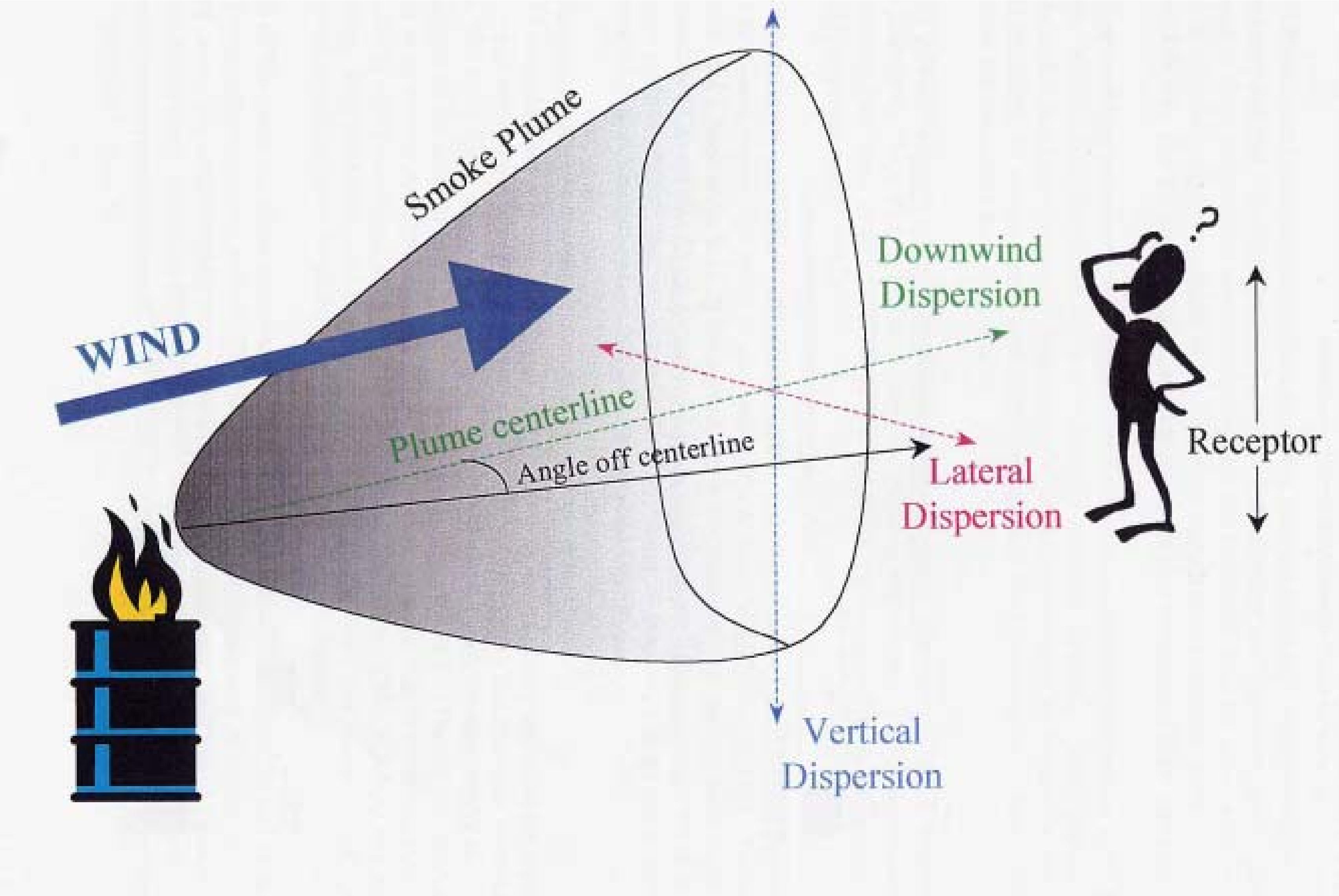
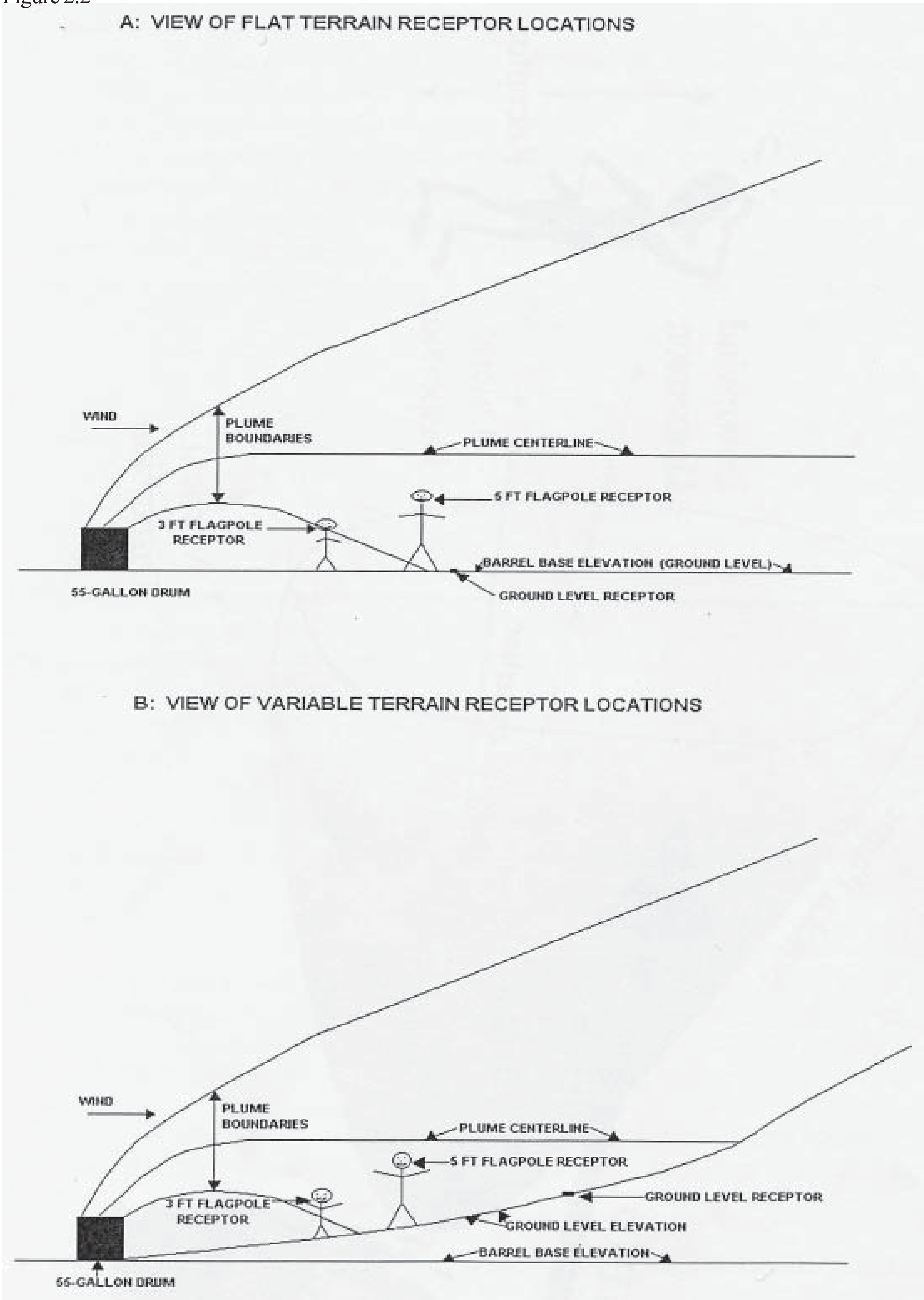


Figure 2.1 Schematic illustrating the major features in modeling the air dispersion of emissions from barrel burning.

Figure 2.2


A: VIEW OF FLAT TERRAIN RECEPTOR LOCATIONS
WIND
PLUME BOUNDARIES
PLUME CENTERLINE
5 FT FLAGPOLE RECEPTOR
3 FT FLAGPOLE RECEPTOR
BARREL BASE ELEVATION (GROUND LEVEL)
55-GALLON DRUM
GROUND LEVEL RECEPTOR
B: VIEW OF VARIABLE TERRAIN RECEPTOR LOCATIONS
WIND
PLUME BOUNDARIES
PLUME CENTERLINE
5 FT FLAGPOLE RECEPTOR
GROUND LEVEL RECEPTOR
3 FT FLAGPOLE RECEPTOR
GROUND LEVEL ELEVATION
BARREL BASE ELEVATION
55-GALLON DRUM

3. Estimating Downwind Concentrations of Pollutants Using Air Dispersion Modeling

The DEP performed screening and refined modeling analyses using the emission rates, exit temperatures and exit velocities described earlier. The modeling analyses were used to generate the range of short term (acute) impacts of pollutants and to identify how far away from the burn barrel the emission impacts exceeded state and federal standards. A summary of the modeling analysis follows. For the complete text, see Technical Support Document (TSD) Appendix 2A.

Screening modeling techniques were used to find the worst-cast scenario that results in the highest impacts. Refined modeling of the worst-case scenario was then run using 5 years of actual meteorological conditions to predict concentrations (impacts) downwind of the burn barrel. In refined modeling, 15 minute steady state conditions are also used but many more meteorological conditions are considered in the analysis.

Specific pollutant impacts were calculated and listed in Table 5. Results in Table 5 show potential health risks from PM_{10}, $PM_{2.5}$, PCDD/PCDF, Pb, benzene and toluene. The fine particulates and dioxin/furans have been further analyzed in this study and are considered to be indicators for potential for public health impacts.

Table 6 (screening) and Table 7 (refined 15 minutes only) were created to determine whether a 15-minute or 1-hour impact will result in a violation of a 24-hour MAAQS or NAAQS. To compare 15-minute and 1-hour impacts to 24-hour standards it was assumed that impacts were negligible for the remaining 23 hours and 45 minutes and 23 hours, respectively. (Note: If open burning occurs for longer periods of time, one would need to multiply those 24-hour impacts by the number of additional 15-minute or hour periods to estimate a revised total impact.)

Fine Particulate Matter Results

ISCST3 screening and refined modeling of various types of open burning scenarios for typical recycler and non-recycler household waste in 55-gallon barrels shows that there are potential health risks from $PM_{2.5}$ and PM_{10} emissions. Just 15 minutes of open burning results in exceedances of the 24-hour PM_{10} MAAQS and 24-hour $PM_{2.5}$ NAAQS. The highest modeled impacts were located at flagpole receptors *within a few feet* of the source of open burning especially in windy conditions at levels around 2.7 times the 24-hour PM_{10} MAAQS and 5.8 times the 24-hour $PM_{2.5}$ NAAQS. (Keep in mind that inhalation of these levels only would occur if a person stayed in place directly under the plume centerline for 15 consecutive minutes.)

Results of this modeling study have shown the potential for health risks within 26 feet of the source of open burning from just 15-minutes of $PM_{2.5}$ and PM_{10} emissions, however, if open burning occurs for many hours in a day, then the potential health risk zone would expand further from the burn barrel. Also note that receptors located within 20° from the plume centerline will also result in fine particulate exceedances within *15 feet* of the source of open burning. (See Table 6 and Figures 2.3 and 2.4).

TABLE 5. ISCST3 MAXIMUM IMPACTS FOR SPECIFIC POLLUTANTS

Pollutant	Avg Period	Test 1 Maximum Impact* (μg/m³)	Test 2 Maximum Impact* (μg/m³)	Test 4 Maximum Impact* (μg/m³)	Test 5 Maximum Impact* (μg/m³)	Short Term Standards* (μg/m³)
$PM_{2.5}$	15-min 1-hr	21722 5430	14350 4895	**53469** **13367**	29472 7368	**65@** **24-hr NAAQS**
PM_{10}	15-min 1-hr	23383 5846	16755 5715	**56692** **14173**	32320 8080	**150** **24-hr MAAQS**
VOC	15-min 1-hr	25981 6495	15332 5230	**63041** **15760**	27222 6805	---
SVOC	15-min 1-hr	439 110	1436 **490**	**1883** 471	976 244	---
HCL	15-min 1-hr	**10284** **2571**	6045 2062	1283 321	172 43	---
HCN	15-min 1-hr	747 187	647 221	**1939** **485**	415 104	---
Total PCDD/PCDF	15-min 1-hr	**1.55** **0.39**	0.19 0.06	0.14 0.03	0.07 0.02	**3.5E-06** **24-hr dioxin and Furan IAAG**
Benzene	15-min 1-hr	3348 837	1515 517	**4702** **1176**	1410 352	450 24-hr IAAG
PAH	15-min 1-hr	74 18	98 33	**219** **55**	99 25	---
Aldehydes & ketones	15-min 1-hr	683 171	276 94	**10545** **2636**	3244 811	---
PCB	15-min 1-hr	3.2 0.8	3.7 1.3	**8.2** **2.1**	5.2 1.3	---
Lead (Pb)	15-min 1-hr	1.3 0.3	**10.3** **3.5**	2.0 0.5	0.4 0.1	1.5 24-hr MAAQS
Chromium (Cr)	15-min 1-hr	**0.74** **0.19**	0.83 0.28	0.61 0.15	0.35 0.09	0.3 24-hr MAAQS
Acetone	15-min 1-hr	733 183	557 190	**3586** **896**	1053 263	3500 24-hr IAAG
Chloromethane	15-min 1-hr	433 108	545 186	**701** **175**	231 58	
Ethyl benzene	15-min 1-hr	433 108	204 70	**1124** **281**	231 58	54000 15-min IAAG
Naphthalene	15-min 1-hr	470 118	212 72	**698** **174**	219 55	7900 15-min IAAG
Styrene	15-min 1-hr	1458 364	705 241	**3224** **806**	516 129	43000 15-min IAAG
Toluene	15-min 1-hr	1282 320	513 175	**1665** **416**	649 162	260 24-hr IAAG

Notes:

MAAQS Maine Ambient Air Quality Standards in MEDEP-BAQ regulations Chapter 110
IAAG Maine Interim Ambient Air Guidelines not in MEDEP-BAQ regulations
NAAQS National Ambient Air Quality Standard
* Maximum impacts occurred with 5 foot flagpole receptors for all test burns

Table 6. Open Burning Contributions to 24-hour $PM_{2.5}$ and PM_{10} Impacts

Pollutant Time Period/ Test #	Time Period Impact (µg/m³)	Contribution to 24-hour Impact (µg/m³)	Background (µg/m³)	Total Impact (µg/m³)	24-Hour Standards (µg/m³)
PM_{10} 15-min.					
Test #1	23383	**244**	35-77	**279 - 321**	**150***
Test #2	16755	**175**	35-77	**210 - 252**	**150***
Test #4	56692	**591**	35-77	**626 - 668**	**150***
Test #5	32320	**337**	35-77	**279 - 414**	**150***
PM_{10} 1-hour					
Test #1	5846	**244**	35-77	**279 - 321**	**150***
Test #2	5715	**238**	35-77	**273 - 315**	**150***
Test #4	14173	**768**	35-77	**626 - 668**	**150***
Test #5	8080	**337**	35-77	**372 - 414**	**150***
$PM_{2.5}$ 15-min					
Test #1	21722	**226**	21-46^	**247 - 272**	**65****
Test #2	14350	**149**	21-46^	**170 - 195**	**65****
Test #4	53469	**557**	21-46^	**578 - 603**	**65****
Test #5	29472	**307**	21-46^	**328 - 353**	**65****
$PM_{2.5}$ 1-hour					
Test #1	5430	**226**	21-46^	**247 - 272**	**65****
Test #2	4895	**204**	21-46^	**225 - 250**	**65****
Test #4	13367	**557**	21-46^	**578 - 603**	**65****
Test #5	7368	**307**	21-46^	**328 - 353**	**65****
Lead (Pb)					
Max 15-minute	10.3	0.11	na	0.11	1.5*
Max 1-hour	3.5	0.15	na	0.15	1.5*
PCDD/PCDF					
Max 15-minute	1.55	**0.016**	na	**0.016**	**3.5E-06@**
Max 1-hour	0.386	**0.016**	na	**0.016**	**3.5E-06@**
Benzene					
Max 15-minute	4702	**49**	na	**49**	**450@**
Max 1-hour	1176	**49**	na	**49**	**450@**
Toluene					
Max 15-minute	1665	**17**	na	**17**	**260@**
Max 1-hour	416	**17**	na	**17**	**260@**

Notes:
* Maine Ambient Air Quality Standard in MEDEP-BAQ regulations Chapter 110
** Proposed Federal $PM_{2.5}$ National Ambient Air Quality Standard.
^ $PM_{2.5}/PM_{10}$ background concentration ratio of 0.60[2]
@ Maine Interim Ambient Air Guidelines (MIAAG)for dioxins and furins not in MEDEP-BAQ regulations
na not available

Table 7. ISCT3 Refined Modeling Open Burning Results Using 5 ft Flagpole Receptors

Pollutant Time Period/ Test #	MAX 24-hour Impact (µg/m³)	Dist. From Barrel (m)	Distance to Compliance (ft)	Wind Speed (m/s)	Time of Day	Back-ground (µg/m³)	Total Impact (µg/m³)	24-Hour Stds (µg/m³)
PM_{10} 15-min.								
Test #1	403	1	**10**	10.3	1 pm	35 -77	**438 -480**	**150***
Test #2	144	1	**7**	15.4	1pm	35 –77	**179 – 221**	**150***
Test #4	323	1	**13**	14.9	10 am	35 -77	**358 – 400**	**150***
Test #5	358	1	**10**	3.1[+]	5 am[+]	35 –77	**393 – 435**	**150***
$PM_{2.5}$ 15-min								
Test #1	375	1	**20**	10.3	1 pm	21 – 46[^]	**396 – 421**	**65****
Test #2	124	1	**13**	15.4	1pm	21 – 46[^]	**145 – 170**	**65****
Test #4	304	1	**26**	14.9	10 am	21 – 46[^]	**325 – 350**	**65****
Test #5	327	1	**20**	3.1[+]	5 am+	21 – 46[^]	**348 – 373**	**65****
PCDD/PCDF								
Test #1	2.7E-02	1	**>1640[a]**	10.3	1 pm	na	**2.7E-02**	**3.5E-06[@]**
Test #2	1.6E-03	1	**148**	15.4	1pm	na	**1.6E-03**	**3.5E-06[@]**
Test #4	7.9E-04	1	**148**	14.9	10 am	na	**7.9E-04**	**3.5E-06[@]**
Test #5	8.0E-4	1	**82**	3.1[+]	5 am[+]	na	**8.0E-04**	**3.5E-06[@]**
Lead (Pb)								
Test #1	2.2E-02	1	na	10.3	1 pm	na	2.2E-02	**1.5***
Test #2	8.9E-02	1	na	15.4	1pm	na	8.9E-02	**1.5***
Test #4	1.1E-03	1	na	14.9	10 am	na	1.1E-02	**1.5***
Test #5	4.9E-03	1	na	3.1[+]	5 am[+]	na	4.9E-03	**1.5***
Chromium								
Test #1	1.3E-02	1	na	10.3	1 pm	na	1.3E-02	**0.3***
Test #2	7.2E-03	1	na	15.4	1pm	na	7.2E-03	**0.3***
Test #4	3.5E-03	1	na	14.9	10 am	na	3.5E-03	**0.3***
Test #5	3.9E-03	1	na	3.1[+]	5 am[+]	na	3.9E-03	**0.3***
Benzene								
Test #1	58	1	na	10.3	1 pm	na	58	**450[@]**
Test #2	13	1	na	15.4	1pm	na	13	**450[@]**
Test #4	27	1	na	14.9	10 am	na	27	**450[@]**
Test #5	16	1	na	3.1[+]	5 am[+]	na	16	**450[@]**
Toluene								
Test #1	22	1	na	10.3	1 pm	na	22	**260[@]**
Test #2	4	1	na	15.4	1pm	na	4	**260[@]**
Test #4	10	1	na	14.9	10 am	na	10	**260[@]**
Test #5	7	1	na	3.1[+]	5 am[+]	na	7	**260[@]**

Notes:

* Maine Ambient Air Quality Standards in MEDEP-BAQ regulations Chapter 110

** National Ambient Air Quality Standard.

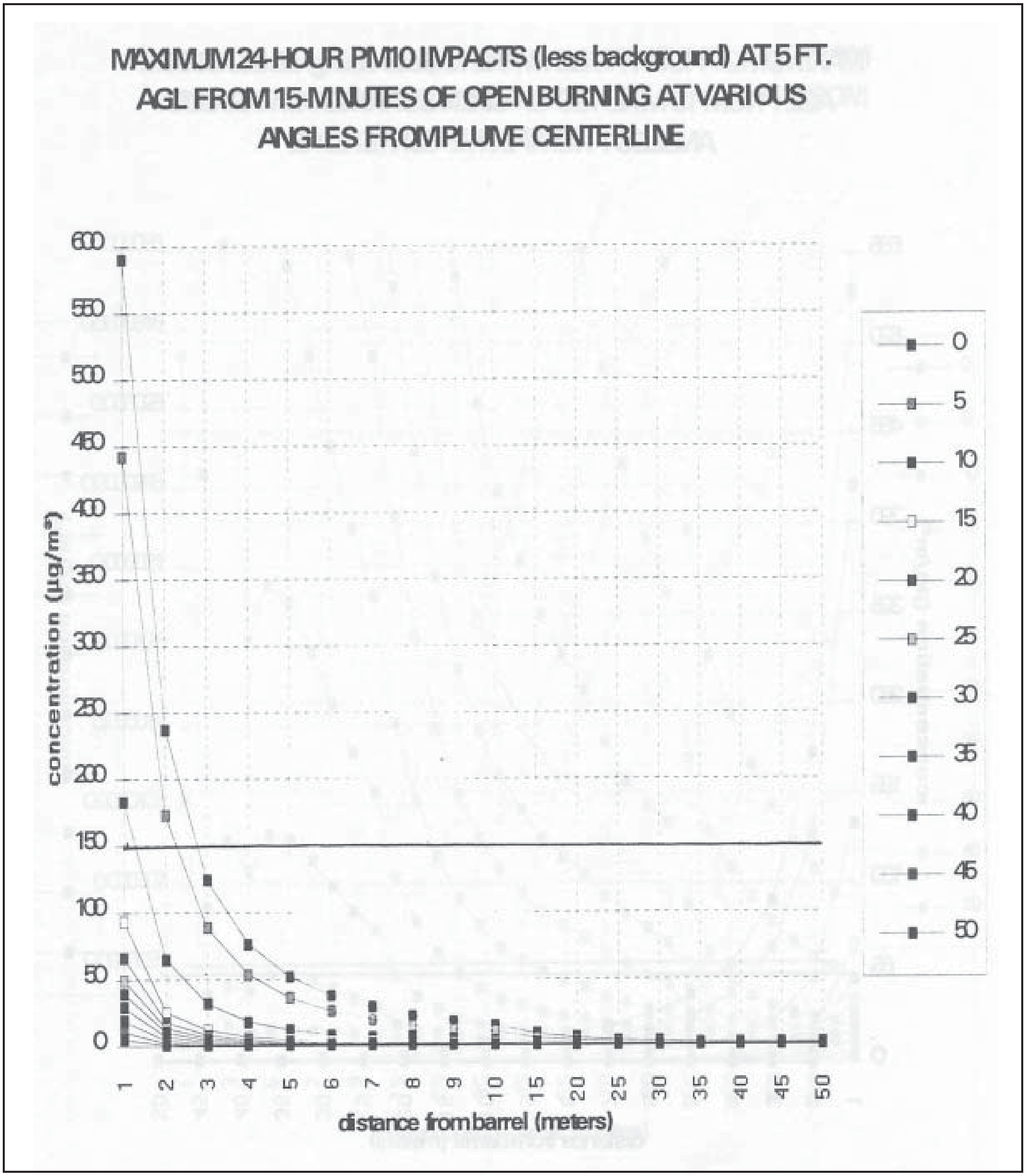
^ $PM_{2.5}/PM_{10}$ background concentration ratio of 0.60[2]

@ Maine Interim Ambient Air Guidelines (IAAG) not in MEDEP-BAQ regualtions

na Not applicable

\+ Also occurred at 10 pm with 3.1m/s wind speed

a Impact at 1640 ft (500m) is 6.67e-06 μg/m3



MAXIMUM 24-HOUR PM10 IMPACTS (less background) AT 5 FT. AGL FROM 15-MINUTES OF OPEN BURNING AT VARIOUS ANGLES FROM PLUME CENTERLINE
concentration (µg/m³)
600
550
500
450
400
350
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 15 20 25 30 35 40 45 50
distance from barrel (meters)
0
5
10
15
20
25
30
35
40
45
50

Figure 2.3

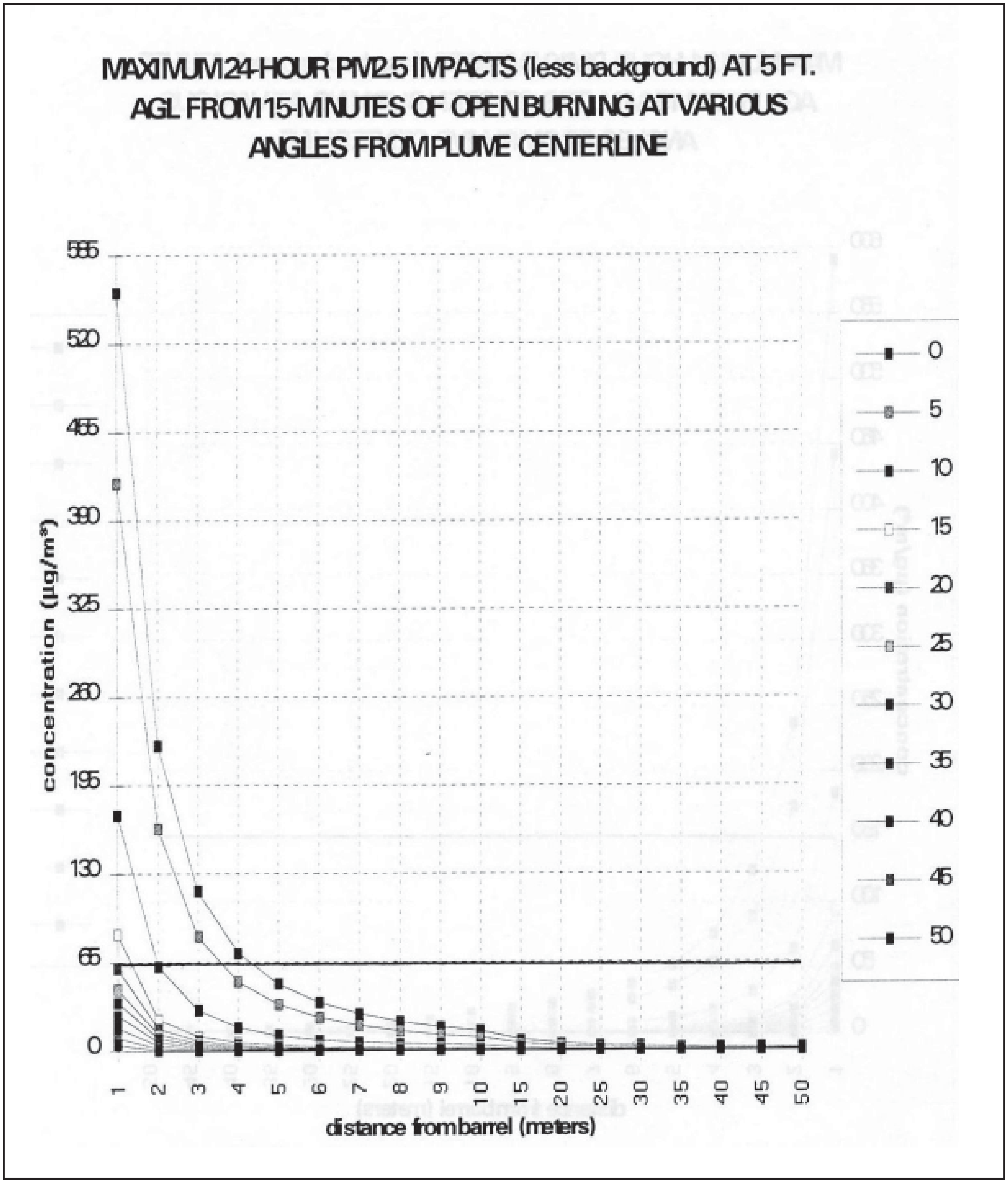
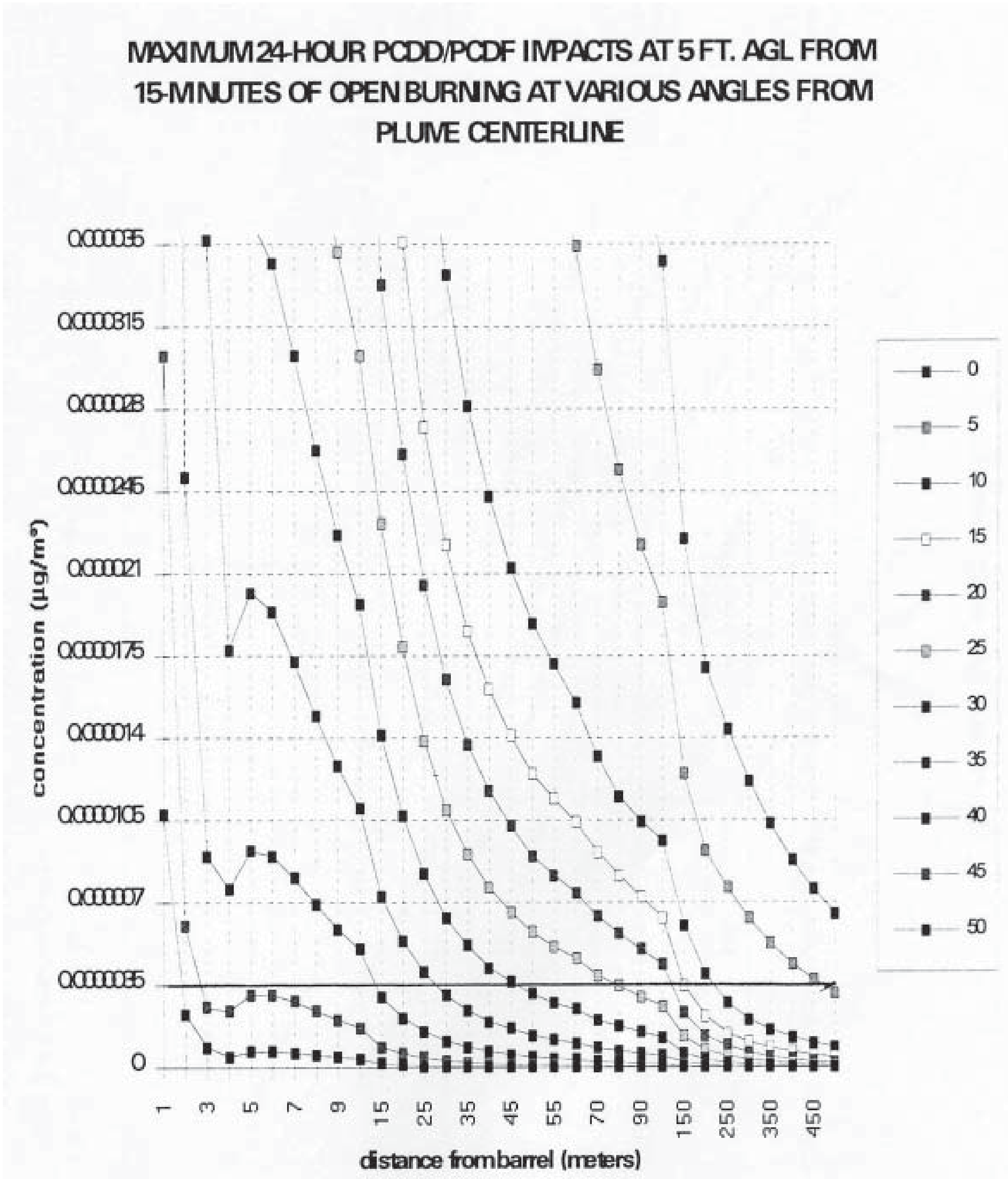

MAXIMUM 24-HOUR PM2.5 IMPACTS (less background) AT 5 FT. AGL FROM 15-MINUTES OF OPEN BURNING AT VARIOUS ANGLES FROM PLUME CENTERLINE
concentration (µg/m³)
585
520
455
390
325
260
195
130
65
0
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40
45
50
distance from barrel (meters)
0
5
10
15
20
25
30
35
40
45
50

Figure 2.4



MAXIMUM 24-HOUR PCDD/PCDF IMPACTS AT 5 FT. AGL FROM 15-MINUTES OF OPEN BURNING AT VARIOUS ANGLES FROM PLUME CENTERLINE
concentration (µg/m³)
0.000035
0.0000315
0.000028
0.0000245
0.000021
0.0000175
0.000014
0.0000105
0.000007
0.0000035
0
1
3
5
7
9
15
25
35
45
55
70
90
150
250
350
450
distance from barrel (meters)
0
5
10
15
20
25
30
35
40
45
50

Figure 2.5

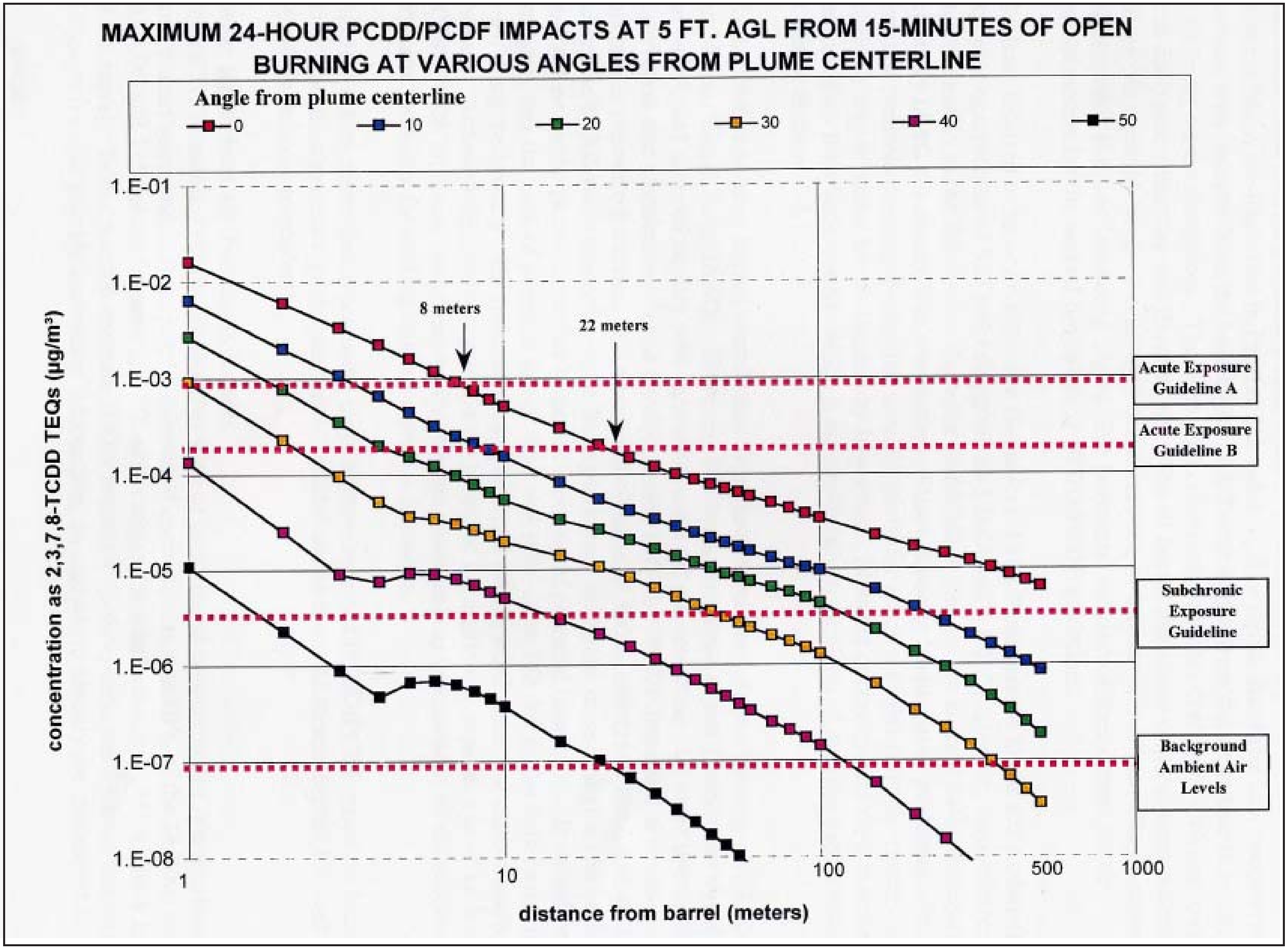


Figure 2.6: Effect of downwind distance and angle from plume centerline of maximum 24-hour ambient air concentrations of PCDD/PCDF.

PCDD/PCDF Results
The results from modeling PCDD/PCDF impacts when using the highest reported PCDD/PCDF emission factor are illustrated in Figures 2.5 and 2.6. The figure illustrates how concentrations decrease with distance from the burn barrel at different angles from the centerline (a 0-degree angle being on the centerline). The lines with color-coded squares denote the different angles from the plume centerline and illustrate the effect of lateral dispersion on air concentrations. Here we see the expected result of concentrations decreasing as the receptor is increasingly moved off the centerline (i.e., an increasing angle). The horizontal red dashed lines denote the air concentrations for the several health-based PCDD/PCDF guidelines.

The lines referred to as *Acute Exposure Guidelines A* and *B* correspond to the acute inhalation exposure benchmarks of 830 and 180 pg/m3 (8.3 E-04 and 1.8 E-04 ug/m3)[4], respectively; the line referred to as the *Subchronic Exposure Guideline* is denotes the current 24-hour (subchronic exposure) IAAG for dioxin. The intersection of lines denoting health-based guidelines with the lines and symbols denoting downwind concentrations for specific angles from the centerline provide a way to assess health impacts by inspection. Modeled concentrations do not include any contributions from background, which is reasonable given estimates of average background levels of dioxin in air of 0.1 pg/m3.

The maximum 24-hour impact contribution from just 15-minutes of open burning was 7,700 times the 24-hour dioxin/furan IAAG. However, this impact occurred at just *1 meter* downwind from the barrel, and dropped rapidly with increasing angle off the centerline. Of more interest is the observation that 15-minutes of open burning results in PCDD/PCDF impacts 2 times the subchronic exposure guideline, at a downwind distance of *500 meters* (1640 feet), and at 100 meters the IAAG was exceeded even at 20 degrees from the plume centerline (i.e., an individual need not be on the plume centerline to get an exposure of potential concern). . It should be noted, however, that the zone of potential health risks was reduced to *148 feet* of the burn barrel or less when using the lower dioxin emission factors reported for the other three test cases (results not shown). Although this study focused on the potential for maximum impacts, use of an 'average' PCDD/PCDF emission factor may be appropriate when making comparisons to the subchronic exposure guideline for making risk management decisions.

Figure 2.6 also shows that when using the maximum reported PCDD/PCDF emission factor, the acute inhalation exposure guidelines were exceeded out to 8 and 22 meters for the 830 and 180 pg/m3 guidelines, respectively.

Other Hazardous Air Pollutants Results
The ISCST3 modeling results showed that without background concentrations, the maximum 24-hour impact contribution from just 15 minutes of open burning was 10% of the 24-hour lead MAAQS and 11% of the benzene and 7% of the toluene non-enforceable IAAG within a few feet of the barrel. Tables 5 and 6 compare HAPS impacts with short-term and 24-hour standards. Although it could provide interesting information, an analysis to identify the downwind distance was not completed for these pollutants which appeared significantly lower than the particulate and dioxin contaminants.

[4] Note: A number of the form 1.8 E-E04 is referred to as scinetific notation for the number 0.00018, and is used to denote powers of ten. (i.e., 1.8×10^{-4}

4. Risk Assessment/Risk Management Considerations: Are these pollutant emissions at levels of concern for public health exposure?

Given the modeling analysis predictions presented in this study, there appear to be scenarios under which barrel burning of trash could cause localized public health impacts. When making risk management decisions about backyard trash burning, state and local officials need to consider whether the risk is acceptable in their communities and/or whether it may be possible to burn without health impacts as long as reasonable distances are maintained from property lines and homes. To assist those officials in making such decisions it may be helpful to further examine the pollutant data which appears to be of highest concern in the modeling analysis.

The modeling results need to be viewed with some caution because the way burn barrels are used by any one individual is highly variable. The modeling analysis is also faced with uncertainties as a result of the variables inherent in the emission factors used, as well as the highly variable meteorological and topographical conditions at any one site. These uncertainties can create both higher and lower predicted impacts. Because there is no good data on the frequency, volume and duration of burning from individual burn barrels, current analyses have focused on potential acute exposures and health impacts, rather than long term exposures and impacts (e.g. cancer).

Recommendations for risk management strategies range from establishing minimum setbacks for allowed burning to considering a prohibition of backyard trash burning. The decision hinges on what level of risk people are willing to accept. Since the dioxin/furan results appear to be at levels of most concern in the modeling analysis, it is recommended to consider using those impacts if considering a setback requirement approach.

There is a strong argument for at least a 22 meter setback, based on potential acute exposure to dioxin and associated health effects. There is also some basis for a setback of 148 feet, based on modeling results using *average* emission factors for dioxin and a subchronic exposure guideline (potential for repeated exposure). And, depending on the level of risk a community is concerned about, there is an argument for a setback of up to 500 meters, based on the subchronic exposure guideline for dioxin; which was exceeded out to 500 meters when using the *highest* dioxin emission impacts modeled in this analysis.

To reiterate the risk management concerns, the acute exposure to dioxin/furans can act as an immunosuppressant making people more prone to become sick and less able to recuperate. It is not known what the effects of a weekly or bi-weekly exposure to such compounds could result in. Therefore, it is important to keep in mind that because of uncertainties in the toxicological studies, there may still be some level of concern for reproductive, developmental or other health impacts in the population.

When making decisions about risk management, state and municipal officials also need to keep in mind the high levels of dioxin/furan that have been found in the ash and the total mass annual emissions to the air. (Refer back to Table 2.4.) A survey of people practicing barrel burning in Illinois indicated that a significant number of respondents disposed of ash by spreading on gardens, piling for wind dissipation, or dumping in ditches or in the forest. Disposal in these ways may result in dioxins pervading food chains, resulting in additional routes of exposure beyond direct inhalation that can be a significant public health concern.

Total mass annual emissions to the air also look high in comparison to other known sources of the pollutant in Maine, and may warrant careful review by the Legislature as it considers ways to reduce the release of dioxins into the environment. The results from the present analysis will be used in the preparation of an inventory of dioxin sources in Maine and state and local risk management decisions may need to be revisited at that time.

Finally, in the case of backyard trash burning, the concern for public health exposure is the same for both the person who burns the trash and the neighbors who are impacted. Public health concern does not start or stop at someone's property line. State and local officials should establish recommended guidelines for impact on the 'burner' as well as those downwind of the barrel. If a community chooses to allow burning, officials need to be cognizant of the impact on people with asthma and other respiratory or heart disease conditions and implement "public nuisance" statutes or other more protective measures when necessary. DEP strongly urges public officials should evaluate whether the risk to their community would be better managed by using an alternative waste management strategy.

SECTION 3: MAINE'S SOLID WASTE MANAGEMENT AND RECYCLING INFRASTRUCTURE

In order to evaluate and recommend alternative waste management strategies to reduce backyard trash incineration, the Maine State Planning Office analyzed the existing solid waste management and recycling infrastructure in the state and the possible dis-incentives to recycle or dispose of waste properly.

A. State Planning Office Analysis on Maine Municipal Solid Waste and Recycling

Municipal solid waste (MSW) is the normal non-liquid waste from households, commercial establishments, and institutions, (e.g., schools and municipal offices). Liquid wastes, discarded automobiles, industrial wastes, hazardous and special wastes are excluded from Maine's MSW definitions.

Maine waste management law establishes municipalities as the primary decision-makers with respect to MSW management matters. Within the context of federal and state law, municipalities choose which other municipalities to cooperate with, how much commercially generated MSW they will handle directly, and what combination of management options to use.

1. Municipal Solid Waste Infrastructure: County Summaries

The recycling and solid waste infrastructure for each county or regional groupings of counties in the state is summarized below.

Aroostook County

- By 1996, 78,000 persons, (98% of the county population), had access to recycling programs. Municipalities near the international border with Canada are investigating opportunities available for disposing of their MSW to facilities in New Brunswick. This action is influenced in part because of the closure of the NARIF facility and the undeveloped Southern Aroostook MSW landfill site. The expenditures associated with having to transport MSW for disposal to the Penobscot Energy Recovery incineration facility in Orrington, (the disposal alternative to Tri-Community or Presque Isle landfills) is influencing these communities to explore the economic feasibility of using disposal facilities that are located in New Brunswick.
- Tri-Community landfill (Fort Fairfield) serves as a regional MSW disposal facility for 20 or more municipalities and several plantations. The landfill is being expanded to a 230,000 ton disposal capacity for a 10-12 year life span. In 1993, activities were initiated to secure MEDEP permitting and licensing for landfill construction and operation of a regional MSW disposal facility designed to serve 12 to 20 communities in the greater Houlton area, (Hammond Plantation), in the southern portion of Aroostook County. By 1995 the solid waste district formed to oversee the development of the facility received approval and site development permits from the MEDEP.
- There are twelve MSW transfer stations located within the county. Most are municipal operations, however, a private operator oversees the operation of the Houlton area's transfer station

Washington County

- Recycling programs are available to 27,650 persons in Washington County.
- There are 10 MSW transfer stations located in the county and in 1995 the Pleasant River Disposal District was formed to help coordinate solid waste management and recycling services for 7 coastal communities.

- The commercial sector's use of composting has increased in the management of blueberry and fish processing wastes that is produced within the region. In 1996, a commercial composting operation began processing organic material for purposes of retail sale within the horticultural and garden center marketplace, as a high quality soil amendment.
- There remains a need for one or more bulky waste processing and disposal facilities for the county.

Mid Maine (Hancock, Penobscot, Piscataquis, Waldo, and Somerset counties)

- In 1996, recycling programs were available for 236,875 persons.
- According to the 1996 municipal solid waste management and recycling reports, 236,875 persons (80% of the combined county population) had access to municipal recycling programs.
- There are 7 licensed, publicly-operated demolition debris landfills, 2 privately owned and operated licensed special waste landfills, 2 publicly-owned, licensed special waste landfills (Anson-Madison Sanitary District, Hartland), 3 publicly-operated, licensed solid waste landfills, 46 MSW transfer stations have come on-line since 1993, within the 5 county area.
- Since 1993, seventeen recycling processing centers are located within the 5 county area. These centers have increased the number of municipal programs accessing their services and have also increased the volume of materials processed for recycling.
- There are 2 publicly licensed and operating MSW landfills within this geographic area, West Forks and Greenville; a commercial landfill is located in Norridgewock.

Central Maine (Kennebec, Knox, Lincoln, and Sagadahoc)

- According to the 1996 municipal reports, 215,915 persons (99%) had access to municipal recycling programs.
- In 1996, fifty-seven communities within the 4 county area used waste-to-energy facilities; 49 used Mid-Maine Waste Action Corp. (MMWAC) in Auburn and PERC in Orrington, 8 used Maine Energy Recovery Corp. in Biddeford. Eight communities used the Augusta Hatch Hill landfill for their MSW disposal needs; three used the commercial landfill in Norridgewock and 3 used Bath's landfill for their MSW disposal.

Western Maine (Oxford, Franklin)

- According to the 1996 municipal reports, 79,130 persons (96%) had access to municipal recycling programs within the 2 county area.
- There are 4 recycling processing centers now available for municipal programs.
- Twenty-eight communities use waste-to-energy facilities, MMWAC in Auburn or Maine Energy Recovery Corp. (MERC) in Biddeford; 11 used the Crossroads Landfill in Norridgewock, and 10 communities exported their MSW to a New Hampshire facility.

Southern Maine (York, Cumberland, Androscoggin)

- From the 1996 municipal annual reports, 502,443 persons (97%) had access to municipal recycling programs within the 3 county area.
- There are 8 recycling processing centers now available for municipal programs within this geographic area.
- Since 1993, there has been an increase in the development and operation of composting facilities, (Windham correctional facility, Hannaford Bros.).
- Even with increasing levels of participation by households in recycling, there always remains the challenge of not only reducing the amount of waste generated but also for improving the recovery rates for recyclable materials at the municipal levels.

2. Overview of Maine Municipal Recycling Infrastructure and Progress

Maine's solid waste management and recycling associations are based on natural affiliations and mutually acceptable inter-local agreements that municipalities initiate. Solid waste management and recycling areas or programs noted in this summary refer to these inter-local affiliations and not state designations of regions. (See TSD Appendix 3B for listing of cities and towns reporting as regions for 1996).

More Maine households are recycling today than ever before. Participation in recycling increased from 72% in 1992 to an estimated 90% in 1996. This summary on municipal recycling is based upon data derived from the 1996 municipal reports. Of the 404 municipalities represented in the 1996 reporting to the State Planning Office, 195 municipalities recycled at a rate of 35% or more. This translates to 48% of the reporting towns recycled at 35% or more. In 1995, 155 municipalities recycled at a rate of 35% or more. This represented 33% of all the municipalities reporting for 1995. This progress in recycling is primarily the result of expansion of recycling programs since 1993 and greater public awareness.

While Maine municipalities are required to report MSW disposal and recycling data for their municipality or solid waste management and recycling association, there is currently no penalty for non-reporting. On the whole, municipalities have been cooperative in providing data using the Municipal Solid Waste Annual Reports.[5]

Recycling

Recycling programs are typically designed and modified to ensure maximum recovery from individual towns. As a result, numerous formats and strategies have been successfully employed throughout the State. Presented here is an overview of common recycling programs and related collection costs (see TSD Appendix 3A for data on individual programs). However, to compare similar programs may be misleading due to the type of information included in each financial report and their particular form of accounting. Other factors to consider when comparing data are whether or not the program is mandatory or voluntary; whether or not there is a fee incentive encouraging recycling; and how long the program has been in place.

Typically, recycling program costs may be broken into three major areas: collection, processing and marketing of recyclables. This analysis focused on the costs related to collection. The relationship between collection of recyclables and delivery to the recycling center represents a major financial cost. The three systems in place in Maine today are:

- **Curbside programs:** a vehicle goes from stop to stop collecting recyclables; that total cost is usually borne by the program.
- **Remote drop-off programs:** collection costs are primarily the investment in containers. Because delivery of recyclables is the responsibility of the generator, hauling filled containers to the recycling center is the major cost to the program.
- **Facility drop-off programs:** the generator delivers the recyclables directly to the processing center. As a result, there are no collection costs to the program.

From another standpoint, the cost to the environment of a curbside program (i.e., one vehicle collecting from 2500 residences) versus 2500 residences delivering their own recyclables to a drop-off facility has a value that is not typically factored into recycling program costs. On the other hand, the number of acceptable recyclables from a drop-off program may be higher in number than with a curbside program.

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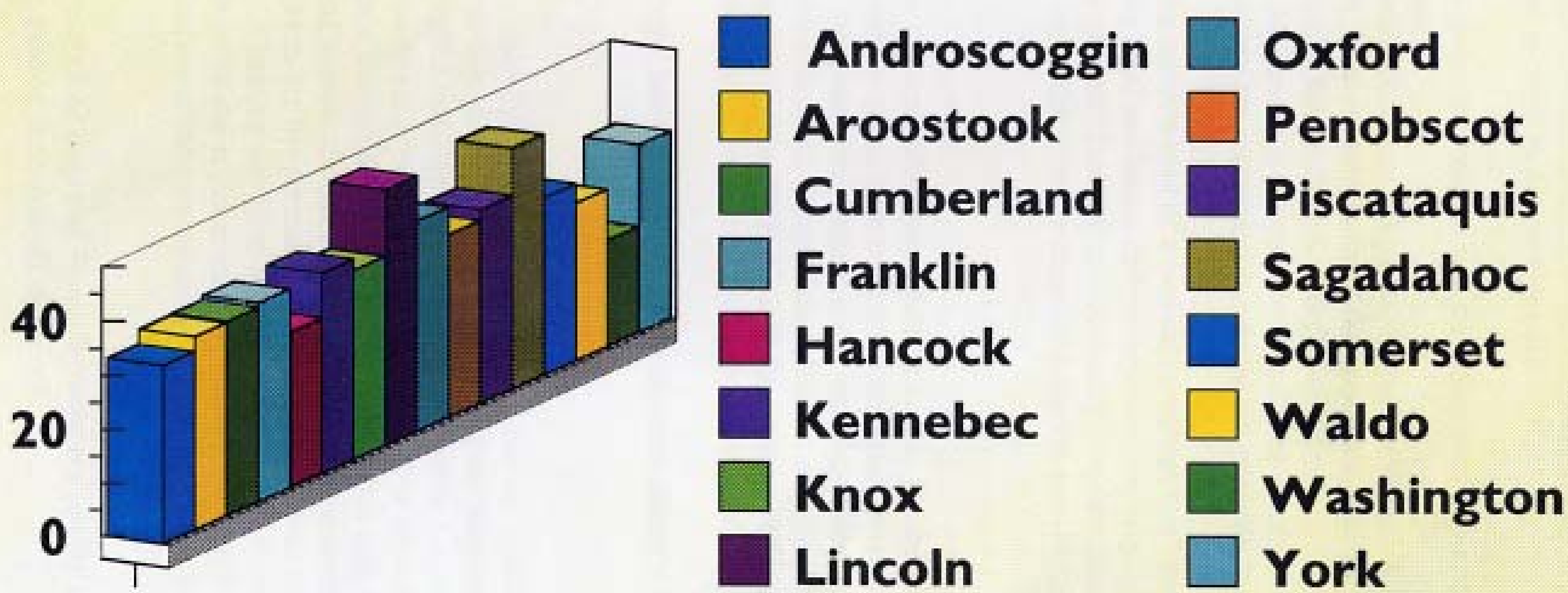
5 For 1995, the State Planning Office estimated that 41% of municipal solid waste was recycled. This is an improvement of the 1993 statewide recycling rate of 33%. The estimate of the statewide recycling rate is calculated by adding together the total amount of waste disposed, recycled, reused. This information is derived from annual municipal solid waste reporting, the private sector Broker/End-User survey, annual reports of disposal facilities, and neighboring state and provincial governments in the northeast region.

Figure 3.1

MAINE COUNTY RECYCLING RATES 1996



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Curbside
Curbside collection is considered to be the most effective collection system for the recovery of recyclables because it is easy for residents to participate and community peer pressure comes in to play. In this program, residents place designated recyclables at the curb for collection by the designated collector, (typically the trash collector). Recyclable collection may be the same day as trash collection (the most effective system) or on another day. Collection may be weekly or less often. The menu of accepted recyclables varies from community to community.

Cost examples: Bath - $.41/stop; Presque Isle (included in trash collection charge); Lewiston $.45/stop.

Remote location drop-off
In this recycling program, containers (typically compartmentalized roll-ons or 'igloos') are placed throughout the community for people to deposit their recyclables. Selection of accessible sites may include shopping centers, public office building areas, transfer stations or major business locations. The containers are hauled away either when the container is full or on a set schedule and the accumulated recyclables are then delivered to a processing center. This type of collection system is most common for regions and groups of communities where the designated recycling center is not easily accessible for residents (or not permitted). The list of accepted materials may vary from region to region. The cost of hauling the filled containers to the processing facility may be borne by the generating community or by the regional entity operating the recycling center. Often a major problem is the contamination of the recyclables within the container by garbage or by unacceptable recyclables.

Cost examples: Some member communities of Regional Waste Systems are paying the contractor between $1.35 and $1.49 per mile for hauling their roll-off container.

Facility drop-off
In this collection format, individuals deliver recyclables directly to the recycling center for processing. This type of recycling program maximizes the education opportunities because the deliverer can easily be shown what and how to recycle, as well as receive information on non-accepted materials. In this format, collection and delivery costs are borne directly by the generator and are not typically considered in determining costs of this program.

Cost examples: There is no direct cost for the collection and transportation of recyclables in this type of program.

B. What is the impact of the state solid waste management and recycling infrastructure on backyard burning?

When the BYB survey data was compared to the municipal recycling rates, there was no correlation between these factors. (See graph entitled Burn Barrel Influence on Recycling Rates in TSD Appendix 3C). Municipal and individual generator costs for managing solid wastes may impact on the number of burn barrels in Maine. Municipal waste management costs reported by Maine Municipal Association are included in TSD Appendix 1A. They range from a low of $1.21 per resident to a high of $622 per resident with an average cost of $61 per resident.

The BYB survey data was analyzed to compare the magnitude of burn barrel use versus the availability of a "trash collection service" or availability of a municipal "transfer station (disposal service)." ***Table 8 below, shows a clear correlation between municipal trash collection service and a low burn-barrel-to-resident ratio,*** however, this probably reflects the state law that prohibits barrel burning in MTCS* communities.

Table 8. Influence of MTCS* and Transfer Station Availability on Burning

	Number of towns	Barrels per 1000 Residents
Towns with MTCS*	130	1
Towns w/o MTCS* w/ Transfer Stn.	241	11
Towns w/o MTCS* or Transfer Stn.	181	12

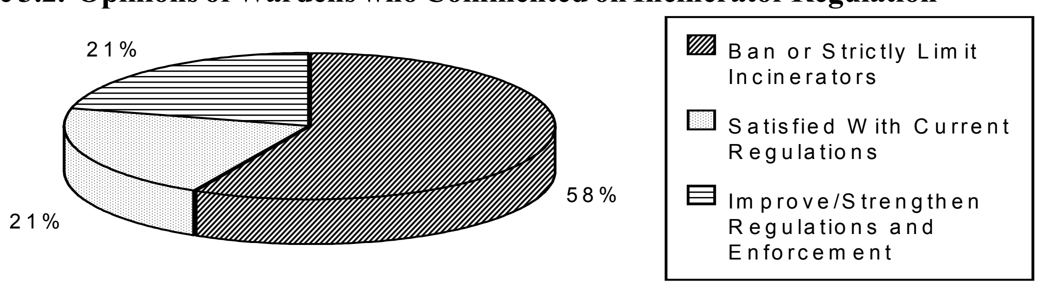
**Municipal Trash Collection Service (MTCS), as defined in Sec. 5 12 MRSA §9324, sub-§7 of the state backyard burning legislation, means "any curbside trash collection service that is operated or contracted for by the municipality or that is required by municipal ordinance."*

Which municipalities are currently subject to state and local level BYB prohibition?

The Bureau of Forestry notified municipalities in all towns with MTCS of the recent change to the definition of MTCS in LD 967. (See TSD Appendix 1B.) Towns that are currently served by MTCS and therefore subject to the state prohibition on open burning are listed in TSD Appendix 1C. Municipalities known to have local ordinances prohibiting backyard burning are listed in TSD Appendix 1D. State law and local ordinances now prohibit backyard trash burning in at least 150 communities statewide.

As part of the BYB Survey, local fire wardens were asked to make general comments about backyard burning. As the municipal officials in charge of permitting open burning and enforcing BYB legislation, many wardens expressed strong opinions about banning or regulating burn barrels. Figure 3.2 shows that the majority of wardens who commented would like to see burn barrels banned, strictly limited or further regulated. The exact wording of warden comments can be found in TSD Appendix 1E.

Figure 3.2. Opinions of Wardens who Commented on Incinerator Regulation



Are there alternative solid waste management strategies that may reduce backyard burning?
For communities where economic reasons are the motivating factors for burn barrel use, finding ways to help communities cope with these costs may be helpful. For example, the island communities often have the highest expenses for many solid wastes and recyclables to the mainland and the BYB survey results (see map 2) show islands with the highest burn barrel use in the state. For communities where inconvenience is the motivating factor, making waste disposal and recycling options easier to use and extending them into rural areas could contribute to reduced burning. In areas where culture and habits are the main factor in burning, extensive education campaigns about the negative effects of burning could help people want to change their habits. One approach that could help reduce municipal waste management costs would be development of a statewide source reduction strategy such as requiring a reduced packaging requirement on products sold in Maine.

SECTION 4: OPTIONS FOR LEGISLATIVE CONSIDERATION

The DEP Bureau of Air Quality formed a study group to review the findings of the backyard burning study and develop recommendations for legislative action. Participants in the study group included representatives from DEP Air Bureau, the Department of Conservation (DOC) Bureau of Forestry, and the Maine State Planning Office (SPO). Advisors to the Study Group included the Maine Department of Human Services (DHS) toxicologist, Maine Municipal Association, American Lung Association of Maine toxicologist and several interested Legislators (see Technical Support Documents, Appendix 4A for a complete listing of contributors and participants).

A. Study Group Recommendations

The Backyard Burning Study Group met on December 19, 1997 to develop recommendations to the Legislature on the problem of backyard trash burning in Maine. The Study Group considered five options for potential legislation:

1) Statewide prohibition of backyard burning
2) Statewide prohibition of backyard burning with rural exemptions
3) Statewide prohibition of backyard burning with rural exemptions for overwhelming financial burden
4) Allowed rural burning with setbacks
5) Allowed burning with setbacks in any community without municipal trash collection service

The Study Group advisors present at the Dec. 19 meeting concluded that Option 5 was the most acceptable approach to implement. This option—allowed burning, with setbacks from neighboring property, in any community where it is not already prohibited—was enhanced by an added education component and incentives for communities to provide municipal trash collection services.

The Study Group advisors also made the following recommendations:

1) Setbacks

The Study Group recommended requiring a burn barrel setback in relationship to neighboring structures or property lines. The group also recommended an "advisory" burn barrel setback distance from the burners' own homes. (Additional analysis is being completed by DEP to develop specific setback distance recommendations.)

2) Municipal Incentives

The Study Group recommended implementing a program to enable communities to deal with backyard burning at the local level by providing incentives, such as recycling credits, or tax credits to encourage towns to provide municipal trash collection service and develop BYB ordinances.

3) Education

The Study Group recommended implementing an educational component geared toward younger generations and modeled after successful recycling and seatbelt education campaigns. In addition, an adult educational program would be created, including a brochure based on the BYB study findings to be handed out with open burning permits.

B. DEP Recommendations
Recognizing the potential for public health impacts from particulates, dioxin and other hazardous air pollutants, the DEP Bureau of Air Quality recommends a concerted effort to reduce the amount of backyard burning in Maine. The Study Group has identified an initial course of action that would have the effect of limiting public exposure to local emissions. The course of action would be implemented through the Group's proposed legislation.

DEP recommends discussion of this proposed legislation in the context of a "first step" toward an ultimate goal of eliminating the harmful health and environmental impacts of backyard burning. Additional considerations should include: (1) identifying the level of public health risk a community is willing to accept; whether setbacks or elimination is most desirable as the risk management strategy (2)establishing a state-wide minimum setback requirement of at least 300 feet from neighboring property lines or structures; (3) advisory setbacks from burners' own residences; (4) local incentives to reduce backyard burning and implement environmentally friendly alternative waste management strategies.

C. Draft Legislation developed based upon the Study Group recommendations.
The draft legislation recommends a minimum setback requirement of 300 feet. Further discussion by the Natural Resource Committee will determine expanded "safety" distances for setback requirements based on their level of concern for potential exposure to dioxin and other hazardous air pollutants or will create a mechanism for towns to implement their own setback requirements.

DRAFT

118th MAINE LEGISLATURE

FIRST REGULAR SESSION - 1998

Legislative Document No.

An Act to Implement the Recommendations of the Interagency Committee on Outdoor Trash Burning

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Be it enacted by the People of the State of Maine as follows:

Sec. 1. 12 MRSA §9321, sub-§1, ¶J, is enacted to read:

<u>J. The proximity to property lines and residential dwellings shall be a minimum of 300 feet.</u>

Sec. 2. 38 MRSA 2133, sub-§2-A, as amended by PL 1995, c.656, Pt.A , §36, is further amended to read:

2-A. Technical and financial assistance program. A program of technical and financial assistance for waste reduction and recycling is established in the office to assist municipalities with managing solid waste. The director shall administer the program in accordance with the waste management hierarchy in section 2101.

Preference in allocating resources under this section must be given to municipalities that take advantage of regional economies of scale or provide a municipal trash collection service as defined in Title 12 section 9324, subsection 7.

Sec. 3. 12 MRSA 9326, is enacted to read:

12 § 9326 Public education

A program of public education on the health, environmental and fire-safety impacts of out-of-door burning is established within the Bureau of Forestry. The director shall administer the program in conjunction with the Department of Environmental Protection and State Planning Office.

STATEMENT OF FACT

This bill makes changes in the provisions of 12 MRSA Chapter 807, Forest Fire Control and 38 MRSA Chapter 24, Solid Waste Management and Recycling to:

1. Address citizen complaints about the numerous barrel incinerators in Maine and the concern for public health impacts from localized emissions of backyard trash burning that include high levels of fine particulates, dioxin/furans and other hazardous air pollutants.

2. Provide incentives for municipalities to reduce the incidence of backyard trash burning through the implementation of recycling and municipal trash collection service.

3. Establish a program of public education to be administered in conjunction with the Department of Environmental Protection and the State Planning Office. The public education program is intended to provide education and outreach activities for primary and secondary schools, along with the distribution of educational materials concurrent with the issuance of any open burning permit.